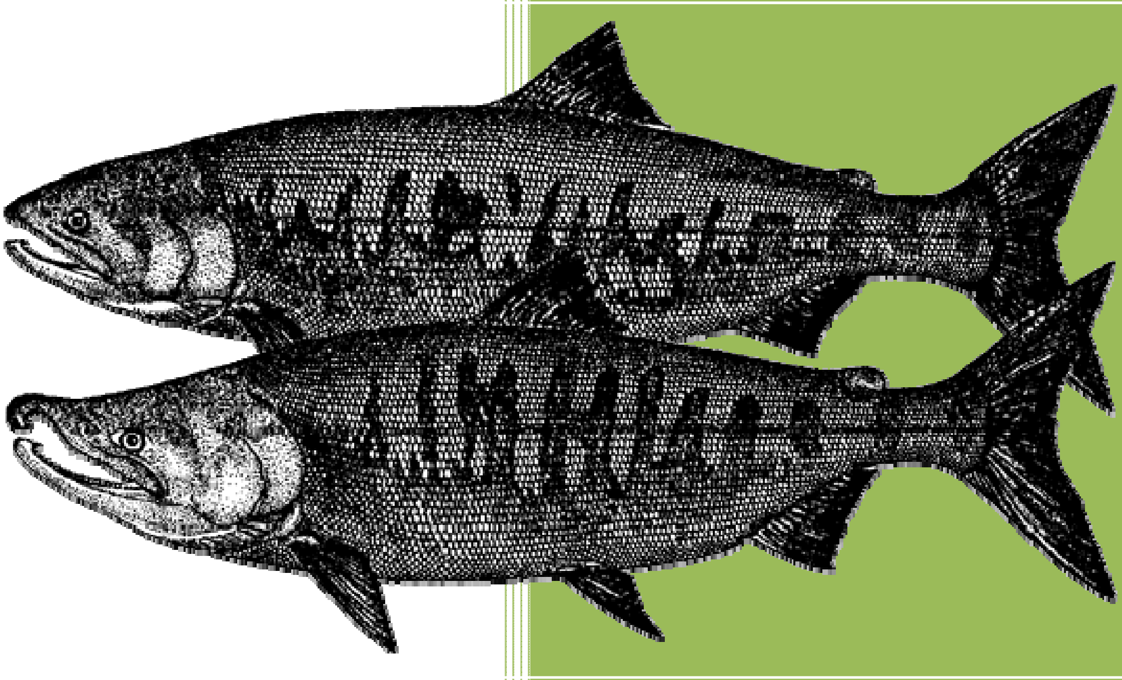
Project 2008-710-00

Washington Department of Fish & Wildlife Response to ISRP Memorandum (2008-710-00) -- April 28, 2009 Review of BiOp proposal "Chum Salmon Enhancement in the Lower Columbia River"



Response by: Steve Vigg, Columbia River Projects Coordinator, Bryce Glaser, Anadromous Fish Unit Leader, and Todd Hillson, Chum Project Leader

Washington Department of Fish & Wildlife, Region 5, Vancouver, Washington

06/05/2009

Page

Table of Contents

List of Tables

List of Figures

Background

The Washington Department of Fish and Wildlife (WDFW) has been a leader for chum salmon monitoring and restoration efforts in the Lower Columbia River since the closure of Bonneville Dam in 1938. During recent years, Guy Norman, Regional Director for Southwest Washington and the Lower Columbia River (WDFW Region 5) has developed the foundation for ongoing chum restoration through the FCRPS Remand / Biological Opinion (BiOp) process.

The Bonneville Power Association (BPA) identified two new "BiOp Projects" relating to the Columbia River chum salmon Evolutionarily Significant Unit (ESU) – BPA project #'s 2008-710-00 and 2008-711-00, in its Start of Year (SOY) budget spreadsheet for FY 2009 projects:

- 2008-710-00 (Assess habitat potential for reintroduction of CR chum) and
- 2008-711-00 (Implement chum reintroduction below Bonneville Dam).

These projects had a combined funding total of $500K as a placeholder in the BPA project management system – PISCES.

In September 2008 – at the request of Guy Norman – Steve Vigg, WDFW initiated internal discussions with Fish Program staff[1] and made inquiries with BPA on how to best allocate these funds as a comprehensive integrated program for lower Columbia River (LCR) chum salmon recovery. Our initial contact was with Jim Geiselman, BPA RM&E Policy Coordinator; he referred us to Jeff Gislason, Artificial Production Policy Coordinator, as BPA's point person on this project – because of the supplementation aspect of the LCR chum restoration efforts. During October, WDFW had discussions with Jeff Gislason, and we decided to combine these projects into a comprehensive unified chum project for the Columbia River chum ESU: "***Chum Salmon Enhancement in the Lower Columbia River – Development of an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam***"

On November 6, 2008 WDFW staff completed an initial draft of the comprehensive Chum salmon restoration framework; this proposal included a phased-approach for implementation in FY2009 and 2010 that would integrate the chum-related work done by WDFW in two ongoing BPA-funded projects, i.e., Evaluate Spawning of Fall Chinook and Chum Salmon Just Below the Four Lowermost Mainstem Dams ("Below the Dams") (#199900301) and Reintroduction of Lower Columbia River Chum Salmon into Duncan Creek (#200105300). We incorporated comments from Jeff Gislason, and submitted a second draft of the chum proposal to BPA on November 13 and a third re-organized revision that addressed all of Dr. Gislason's remaining comments with a revision on December 12, 2009. During this proposal revision process, Dr. Gislason had been

[1] WDFW staff with a long history of involvement with LCR chum monitoring and restoration efforts include Todd Hillson (WDFW Chum salmon project leader for Region 5), Joe Hymer, Bryce Glaser, Dan Rawding, Maureen Small and Steve Schroder.

coordinating with Bill Maslen, BPA Fish & Wildlife Division Director. Mr. Maslen began the coordination of this new proposal with the Council staff in mid-November, and assigned Tracy Hauser as the Contracting Officer's Technical Representative (COTR) in December 2008. On December 4, we received a BPA budget template from Ms. Hauser to re-format the proposal budget, and Todd Hillson had some discussions with Ms. Hauser regarding budget amounts for FY2009 and FY2010. At the same time (December 4, 2008), Ms. Hauser began a review of the proposal and also referred it to Scott Bettin – who has extensive experience with the effects of Hydropower Operations on chum salmon and fall Chinook spawning below Bonneville Dam. Todd Hillson, WDFW Project Leader, subsequently received e-mail comments originating from Mr. Bettin through Ms. Hauser on January 23 – requesting that we add a component in FY2009 to address the problem of invasive exotic plants in the Hamilton Spring spawning channel that could reduce future chum spawning effectiveness. This work element was added into a final draft of the WDFW chum proposal version 1-29-2009 v3, but the date on the proposal was unchanged, i.e., January 7, 2009. On January 29, Mr. Hillson completed entry of the work elements into PISCES and attached (in PISCES) a line-item budget and the final updated written proposal/SOW for BPA project #2008-710-00.

After the January 29th update, BPA indicated the proposal should be submitted to the Council for ISRP review. On February 6th, Bryce Glaser also sent a copy of the final BPA-approved version (1-29-2009 v3) to Jeff Breckel, LCFRB for their review.

On February 4, we received a project review template[2] from BPA to enter the proposal narrative into a standard review format. The guidance we received from BPA was to put only the FY 2009 narrative into the BPA-ISRP review form – because that was the specific work that needed review prior to funding. As a result, some of the technical background information and multi-year project design was excluded from the template.

On February 23, Mr. Bettin had follow-up questions regarding: (a) the methods for removal of plants from Hamilton Creek, (b) permitting for seining in the vicinity of chum redds, and (c) how and when could the Duncan Creek passage issue be resolved. On February 24, Todd Hillson spoke with Mr. Bettin regarding his comments/questions, and subsequently addressed each of these issues in an e-mail to Ms. Hauser. Mr. Bettin concurred with the solutions proposed by Mr. Hillson, and Ms. Hauser stated that the proposal narrative would be forwarded on to the ISRP.

On March 11, Bonneville Power Administration submitted a 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) Project 2008-710-00 narrative for Independent Scientific Review Panel (ISRP) review (Letter from Bill Maslen, BPA to Tony Grover, NPCC). The initial contract was slated to start May 1, 2009 with a BPA FY09 funding commitment of $265,082.

[2] Tracy Yerxa, BPA, provided the template that had previously been used for Tribal MOA "Accord Projects" to Ms Hauser – at this point it was an untested prototype for use with "BiOp Projects'.

> "We are enclosing the detailed narrative for Chum Salmon Enhancement in the Lower Columbia River, Project #2008-710-00 for immediate ISRP review. The purpose of the project is to develop an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam."

Although, BPA attached the full proposal to the transmittal letter, it is apparent – by the organization (headings) of the ISRPs specific comments – that the abbreviated template proposal was the document actually reviewed by the ISRP. On April 28, 2009, the ISRP Memorandum 2009-14 was submitted to NPCC management and subsequently to WDFW – with the following introductory background information and recommendation:

> "***Background***
>
> *At the Council's March 12, 2009 request, the ISRP reviewed Washington Department of Fish and Wildlife's proposal, Chum Salmon Enhancement in the Lower Columbia River. This proposal is intended to meet needs identified in the 2008 Biological Opinion (BiOp) for the Federal Columbia River Power System by promoting recovery of lower Columbia River chum salmon populations through development of an integrated program for chum salmon habitat restoration and supplementation/reintroduction.*
>
> ***ISRP Recommendation and Summary Comments:***
>
> *Does not meet scientific criteria. Response Requested – The proposal content is insufficient for a complete assessment. A more thorough proposal is needed."*

In hindsight, we believe our direction – to focus on the FY2009 work in the review template – resulted in omission of important information and ultimately caused problems with respect to the ISRP's understanding of the technical background, rationale, and phased approach of the WDFW chum enhancement proposal. Also, during our development of the proposal, it had been reviewed by BPA staff who were fully knowledgeable of the history of BPA-funded LCR chum projects – so we didn't recite all the background information that was in previous chum project proposals. Therefore in retrospect, it is not surprising that the ISRP concluded that the WDFW proposal was incomplete and inadequate for a scientific review. We should not have assumed that the abbreviated information provided in the template version of the proposal was adequate for reviewers that may not be familiar with all the previous work on chum salmon restoration in the Lower Columbia River. In summary, we believe the ISRP reviewers would have gotten a better understanding of the proposed Project 2008-710-00 if they reviewed the complete (1-29-2009 v3) proposal instead of the template. However at this juncture, we will fill in the background information as requested by the ISRP. WDFW would also welcome the opportunity to make a presentation to the ISRP – in addition to a complete written response – to answer any and all questions and concerns.

WDFW Response to ISRP Comments

Approach for the WDFW Response Document

In this response document, we will address the ISRP's general comments and provide more detailed background information on the causes for decline and limiting factors for chum salmon recovery in the lower Columbia River. We will also respond to the seven specific areas that the ISRP requested additional information. In the ISRP's "comments by proposal section", we will identify any specific questions or issues not previously covered, and provide specific responses to those comments as well.

Finally, in Attachment 1 – we will provide a revision of our full proposal – to include the additional background information and linkages that we provided in our general and specific responses. In the updated full proposal, we will highlight revisions and additions in color-coded font to facilitate the final assessment of our response by BPA, Council staff, and the ISRP reviewers.

The ISRP made four general comments.

We broke out the ISRP's general comments into four points for response.

Response to General Comment #1:

1. "The purpose of this proposal is to integrate a variety of chum salmon assessment and restoration actions – some of which are new, some that have been completed (the recovery plans), and some that are ongoing but currently without funding (Grays River supplementation). Integration of these chum salmon restoration activities is encouraged."

Summary of Completed Actions:

Fish manager's response to the federal Endangered Species Act (ESA) listing has been primarily through direct-recovery actions: reducing harvest, promoting hatchery supplementation using local broodstock for populations at catastrophic risk, increasing habitat restoration (including construction of spawning channels) and flow agreements to protect spawning and rearing areas. Both state and federal agencies have supported the development of controlled spawning areas to restore depleted chum populations. The following points summarize the information provided by three important ESA documents:

a) As noted by the ISRP, the initial NMFS chum salmon status review (Johnson et al. 1997) did not provide an in-depth review of limiting factors and causes for decline of LCR chum salmon; it provided more detailed information on Puget Sound populations.

b) The Lower Columbia River Recovery Plan (LCFRB 2004) includes a detailed summary of limiting factors by subbasin, and proposed actions to address these factors (see Specific Response #1 for details). The LCFRB has also developed methodology for ranking proposed habitat projects based on biological effectiveness (see Appendix 5 for details). This information and methodology will be incorporated into our comprehensive strategy for chum salmon reintroduction/supplementation – to be developed during the first year of the project.

c) The cumulative effects analysis of the NOAA Fisheries FCRPS Biological Opinion (NMFS 2008, Section 8.9) summarizes the key limiting factors for Columbia River Chum salmon (see Specific Response #1 and Appendix 2).

Summary of Ongoing Actions:

WDFW has conducted a chum salmon supplementation program in the Grays River basin since 1998 using native broodstock and releasing fed-fry to maintain an at-risk stock. This program has continued through 2007 – with various funding sources – but is currently unfunded. WDFW initiated this program to prevent possible near-complete loss of brood years due to the highly dynamic and unpredictable nature of the basin and the risk of losing the Gorley Springs spawning area, the only protected off-channel spawning area in the basin. The Gorley Springs area was in fact lost in the winter of 1999 to an avulsion that destroyed the dyke protecting it. Annual releases of fed-fry have varied between 400K (initially) and 120K (more recent) in response to increased adult returns.

Refer to the section on "Grays River Supplementation" in our original full proposal for more information (see Attachment 1 page 14). The Grays River program was modeled on, and developed under, the guiding standards of successful chum salmon supplementation programs implemented in the Puget Sound and Hood Cannel (WDFW and PNPTT 2000; Ames and Adicks 2003; Johnson et al. 2003; Schroder and Ames 2004).

In 2001, WDFW and the Pacific States Marine Fisheries Commission (PSMFC) received BPA funding (project # 2001-053-00) to construct/restore spawning channels in Duncan Creek and evaluate two reintroduction strategies – (1) recolonization of the channels through release of adult spawners into the channels, and (2) direct plants of hatchery reared fed-fry released at the mouth of Duncan Creek– and natural recolonization through straying. This project is ongoing; however, budget reductions in FFY08 eliminated the hatchery release component of the project. Results from this project are intended to help guide reintroduction strategies in other Lower Columbia River areas.

Beginning in April 2009, WDFW is working – in conjunction with LCFRB, LCREP and other partners – on implementing a new FCRPS BiOp Estuary Memorandum of Agreement (MOA) with BPA and the Corps. WDFW will be the lead for identifying and sponsoring new habitat restoration projects in the LCR below Bonneville Dam. As this process develops, WDFW will integrate high priority estuary habitat restoration projects – focused on ocean type salmon – with the comprehensive Chum Salmon Enhancement Project.

How this Proposed work will Integrate New Actions:

In BPA's submittal letter to the Council, it summarized new actions targeted for 2009:

- The initial contract is slated to start May 1, 2009[3] with a BPA FFY09 funding commitment of $265,082;
- This will provide for planning stages of the subsequent comprehensive project;
- It will initiate the NPCC Three-Step process for the Grays River chum salmon supplementation program; and
- It will also provide habitat work to remove the canary reed grass from the Hamilton Springs spawning channel graveled/watered areas before the 2009 chum salmon spawning season."

The project is intended to implement several actions required by the FCRPS BiOp RPA:

a) RPA action 42: "Fund a hatchery program to re-introduce chum salmon in Duncan Creek including capital construction, implementation and monitoring and evaluation as long as NOAA Fisheries considers it beneficial to recovery and necessary to reduce risk of the target population." This is essentially the ongoing work previously funded under Project 2001-053-00, Reintroduction of Lower Columbia Chum Salmon into Duncan Creek, and now proposed for inclusion in Project 2008-710-00."

b) RPA action 42: "Fund the assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River tributaries below Bonneville Dam." This is new work. "

c) RPA action 17: "The project will contribute to monitoring of chum salmon spawning in the mainstem Columbia River in the area of the Ives Island Complex and/or access to the Hamilton and Hardy Creeks for this spawning population."

We are encouraged that the ISRP supports the integration of all LCR chum restoration activities into a comprehensive framework. This holistic conceptual approach is the basis for Project 2008-710-00.

[3] Tracy Hauser, BPA COTR, revised the projected start date to July 1, 2009 for pre-award.

Response to General Comment #2.

> 2. "The ISRP finds that the proposal itself would benefit from better organization and presentation of more thorough background on the various activities to be integrated, including an explanation of the need for the integration and a summary of the outcomes from past work. In particular, scientific justification for the actions based on limiting factors analyses is required."

The incomplete organization of the proposal that the ISRP reviewed was due, in part, to the format of the narrative template that BPA provided and the guidance to include only the narrative pertaining to the FY2009 work. Thus, we did not include the full project background and phased approach of future work in the template that was described in the complete WDFW proposal (1-29-2009 v3). As we highlighted in the text box in the previous section – the BPA template limited the information we provided because the FFY2009 portion of the proposal narrative – that was copied into the BPA review template – did not include the overall scientific foundation and phased approach that was described in the complete proposal. Also, we did not provide extensive information on previous BPA-WDFW chum projects and ESA documentation on chum salmon population history and status – that we believed was common knowledge of the Columbia Basin scientific community.

In our responses to seven specific ISRP Requests for additional information that follow, and in our revised proposal narrative (Attachment 1), we will provide a thorough presentation of the historical context and technical background on the various activities to be integrated, including an explanation of the need for the integration and a summary of the outcomes from past work. We provide the scientific justification for the actions based on limiting factors analyses in more detail in WDFW Response to ISRP Request #1 (below).

Phased Approach and Major Components of the Proposal

The ISRP identified seven objectives in the Project 2008-710-00 Review Template:

- Objective 1: Habitat restoration and chum channel site assessment;
- Objective 2: Lower Columbia River chum salmon stock status review;
- Objective 3: Develop a supplementation/reintroduction strategy for Lower Columbia River chum salmon;
- Objective 4: Population monitoring and evaluation program development;
- Objective 5: Grays River chum salmon supplementation;
- Objective 6: Removal of invasive vegetation in Hamilton Spring channel;
- Objective 7: Initiate Three Step Review for a least one top ranked project identified by the habitat restoration and chum channel site assessment.

But the ISRP did not present or review these objectives within the Phased Approach (Phase 1: FFY2009, and Phase 2: FFY2010 and outyears) and framework of the major components of the full WDFW proposal. On page 5 of the original proposal, WDFW identified the phased approach –"*The purpose of the proposed work is to promote recovery of LCR chum salmon populations*":
Phase 1: Development of an integrated program for chum salmon habitat restoration and supplementation/reintroduction in FFY 2009;
Phase 2: Full implementation of the program in FFY 2010.

WDFW further described "Program development in FFY 2009" within the framework of five components, and deliverables within each component:

1) An assessment of priority habitat restoration and/or chum channel sites;
    a. Deliverables:
        i. Prioritized list of potential habitat restoration projets and chum salmon spawning channel sites in Washington LCR tributaries describing the benefits of each.
2) An updated stock status review of LCR chum salmon population structure and abundance necessary to prioritize restoration and guide future implementation of supplementation/reintroduction;
    a. Deliverables:
        i. Processing and analysis of otolith and DNA samples identified in Table 5 (of original proposal).
        ii. Updated genetic analysis of LCR chum salmon population structure.
        iii. Update of WDFW's Salmonid Stock Inventory database (SaSI) with current population structure and updated abundance data.
3) Adaptive management of existing supplementation programs;
    a. Deliverables:
        i. An Adaptive management plan to be integrated with the M&E Plan (#5 below).
4) Development of a stepwise enhancement program that utilizes supplementation/reintroduction to rebuild LCR chum populations
    a. Deliverables: FFY 2009 - Maintain Grays River Supplementation Program
        i. Up to 200,000 chum fry released from the Grays River Hatchery in spring 2010, thermally marked for identification upon recovery via otoliths from adult carcasses.
        ii. An NPCC Three-Step review for the Grays River Supplementation Program.
        iii. Development of a supplementation/reintroduction strategy for LCR chum salmon to link with habitat restoration and chum channel project implementation. Including:
            1. Identification of priority populations for supplementation/reintroduction.

        2. Identification of supplementation/reintroduction method(s) suitable for priority populations.
   b. Develop strategy for future supplementation/reintroduction programs.
      i. In FFY 2009, we propose to develop a strategy that incorporates population recovery designations (Table 2, of original proposal), updated genetic and abundance information and potential habitat restoration/chum channel projects in identifying:
         1. priority populations for supplementation/reintroduction,
         2. preferred methods of supplementation/reintroduction for these populations, and
         3. the genetic stock source (donor stock) for each, including:
            a. stock source for supplementation/reintroduction of priority populations.

5) Development of a comprehensive program to monitor LCR chum salmon populations and evaluate the effectiveness of habitat restoration and supplementation/reintroduction actions[4].
      i. Development of an M&E program for LCR chum salmon populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/reintroduction programs and habitat restoration actions.
      ii. Development of associated budget.

In WDFW's full (1-29-2009 v3) proposal, an FY2009 and (where relevant) an FY2010 budget was developed for each of the major components described above.

The detailed description of the WDFW Integrated Strategy for LCR chum salmon enhancement is presented in the WDFW response to ISRP General Comment #3 (below). The integration of the major components and deliverables outlined above is illustrated in Figure 1 of the following section.

Response to General Comment #3.

3. "This proposal is a good place to begin this integration. Restoration of Lower Columbia River chum salmon is obviously important, yet the sponsors do not clearly describe how this new plan will differ from or be a substantial improvement over the existing (previous) planning efforts."

---

[4] An initial M&E Plan for the Duncan Creek Chum Project was developed by Schroder (2000); that document will be a starting point – in conjunction with our conceptual Adaptive Management Plan – for a comprehensive M&E Plan for Project 2008-710-00.

A general theme of the ISRP comments on the WDFW Project 2008-710-00 Chum proposal is that an integrated chum salmon enhancement plan for the LCR ESU is already in place and it is unnecessary for WDFW to develop "*an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam*" (as it states in our project title). An example of this theme is on page 3, No. 1 of ISRP "*Comments by Proposal Section*":

> *"The technical justification is not sufficient for reviewers to determine whether the proposed new integrated plan is necessary. There is already an existing integrated plan (Lower Columbia Fish Recovery Board [LCFRB] Salmon Recovery Plan 2004)."*

WDFW has worked continuously with the LCFRB in the development and implementation of the LCR Salmon Recovery Plan from its inception, and we will continue to do so. The LCFRB (2004) plan provides important background information specific to all the southwest Washington subbasins and information on the status and limiting factors for the ESA-listed salmonid stocks – including chum salmon. Furthermore, WDFW managers serve on the Board and on the Technical Work Groups that conduct the habitat restoration planning and project selection process. That being said, although the 2004 Plan is a great foundation for ongoing work, it is not the "*end-all be-all*" for chum salmon management, data management, and implementation of chum enhancement and habitat restoration strategies in the lower Columbia River.

In fact, the authors of the LCFRB (2004) Salmon Recovery Plan acknowledge that it is a conceptual framework to provide a systematic regional approach, but additional study designs, and statistical methodology will be detailed in project work plans that will be developed as implementation planning proceeds:

> *"This plan provides the framework for a systematic regional approach. It generally identifies what needs to be done and how to do it. It does not drill down into specific implementation details such as desired confidence levels, statistical power, data collection protocols, sample sizes, etc. These details will depend on additional refinements to the monitoring, research, and evaluation elements of this plan that will be developed as implementation planning proceeds. Refinements will be predicated on the availability of resources for conducting an integrated monitoring, research, and evaluation program."*

Thus, the WDFW Integrated Strategy for Project 2008-710-00 addresses the implementation phase of chum salmon recovery work as envisioned by the LCFRB (2004) Salmon Recovery Plan.

Description of the WDFW Integrated Strategy for LCR Chum Salmon Enhancement

WDFW believes that a full review and subsequent revision of documentation that guides lower Columbia River chum salmon recovery (state/federal stock status reviews and recovery plans, risk assessments, etc.) needs to be conducted. An integrated plan for chum salmon management and restoration needs to be updated to reflect the latest data on chum salmon stocks in this ESU.

Significant new information has been collected regarding chum salmon population trends and genetic relationship structures since the initial NMFS LCR chum status Review (Johnson et al. 1997) and the LCFRB Recovery Plan was written in 2004. WDFW has done population assessments and concurrently collected chum salmon DNA samples from many locations in the LCR, and we plan on analyzing these samples immediately upon contract approval[5]. We will use this information to update chum salmon stock structure and genetic inter-relationships throughout the ESU – and this information is relevant to decisions on appropriate donor stocks for reintroduction into specific habitats. This new stock information will also be incorporated in Project 2008-710-00 Integrated Strategy and Adaptive Management –M&E Plan (Figure 1).

Another major change that has occurred since the LCFRB (2004) Plan was written is the decline of stronghold stocks. Populations that were generally increasing prior to 2003 – e.g., Grays, Ives, I-205 – have shown a declining trend in recent years. Refer to Table 5 and Figures 4 and 5 and in the stock status section in WDFW Specific Response #1.

During the development of the integrated project strategy in year 1, we will concurrently be identifying and assessing potential reintroduction locations. This is an important initial step in recovering chum salmon below Bonneville Dam. There are already several locations in Washington tributaries that have been identified by WDFW as being very good candidates for habitat improvements and/or chum salmon reintroduction. The process of planning reintroduction implementation can and should occur concurrently with habitat assessments during the first year of the project. In addition, there are programs/actions that are already in earlier planning documents that will not happen in FFY09 without the funding that will be provided through Project 2008-710-00.

The sequencing of tasks in the development of WDFW's integrated strategy – during the first year of the project – to implement habitat restoration and chum reintroduction in the tributaries below Bonneville Dam is illustrated in Figure 1.

[5] The existing genetic samples will be analyzed by the Science Division staff at the WDFW Molecular Genetics Lab; Dr. M. Small will be the principal investigator on the chum salmon population genetics analyses and subsequent update of previous publications.

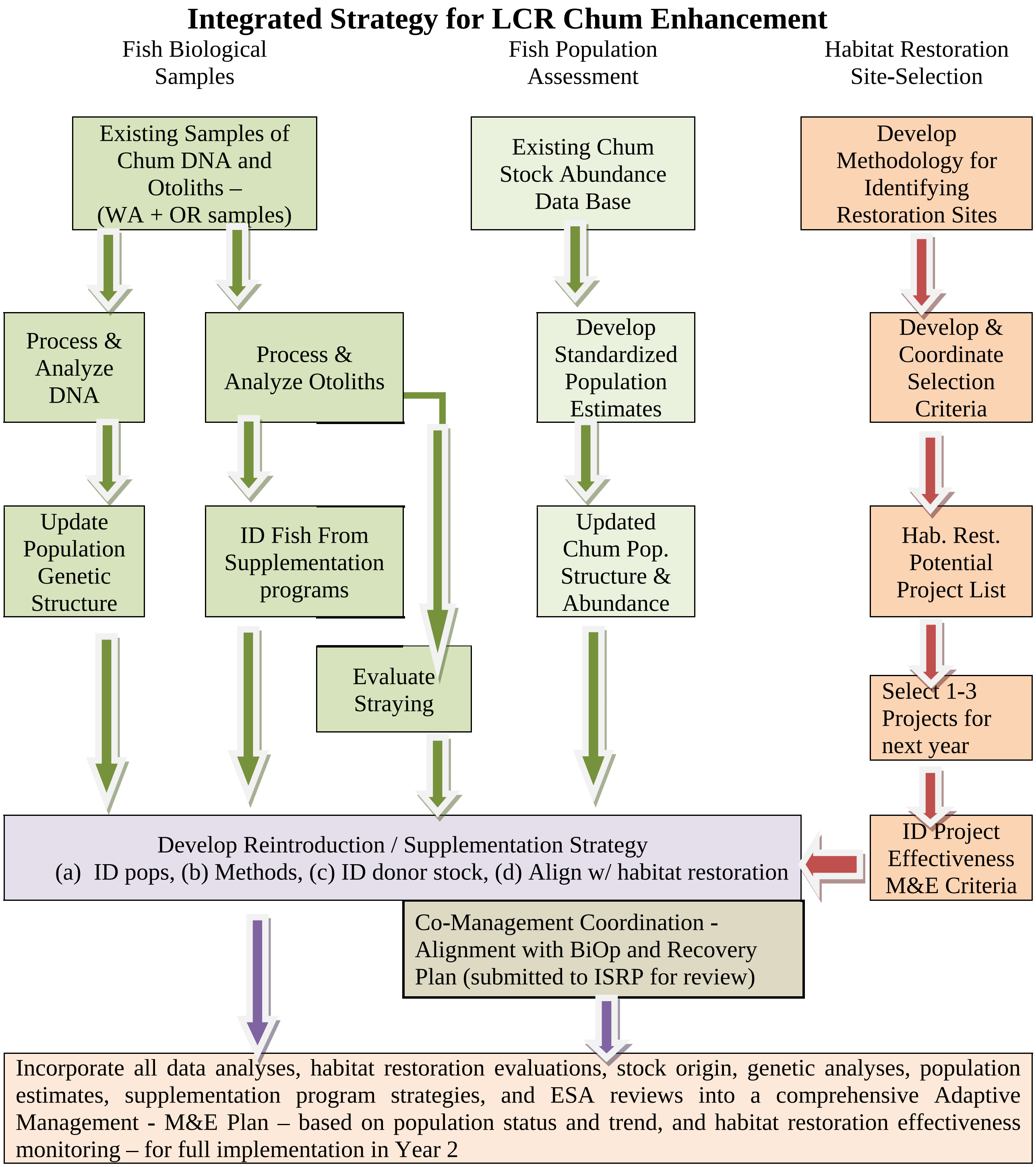


Figure 1. Flow chart of Project 2008-710-00 activities supporting the development of an Integrated Strategy for LCR Chum Enhancement.

We refer the reader to our response to specific ISRP Request #4 (below) for additional details and descriptions regarding the schedule of activities and tasks presented in Figure

1. Additional information regarding the timelines for completion of specific Objectives is presented in WDFW Response #4, as well.

Provisions of the NOAA Fisheries 2008 FCRPS BiOp and the WDFW-Federal Estuary MOA add $90 Million in new Habitat Restoration Work Below Bonneville Dam

Other major actions that have occurred since the writing of the LCFRB (2004) Recovery Plan are implementation and completion of significant restoration projects – plus greatly increased funding for habitat restoration in the Columbia River Estuary[6] authorized for the next decade:

- Ongoing and completed tributary habitat restoration projects selected by LCFRB for Salmon Recovery Funding Board (SRFB) funding during 2004-2009;
- Lower Columbia River Estuary Partnership (LCREP) habitat projects ongoing and completed in the lower estuary (refer to Figure 2);
- NOAA Fisheries Service's May 2008 FCRPS BiOp authorized $49.5 million to conduct estuary habitat work over the next 10-years – largely in coordination with the Estuary Partnership;
- The WDFW "estuary MOA", will fund an additional $40.5 million of estuary habitat restoration during 2010-2018 – with a goal of significantly enhancing survival of stocks of anadromous salmon and steelhead listed under the ESA

In 2008, the federal action agencies had previously dedicated $49.5 million to estuary habitat work over the 10-year course of NOAA Fisheries Service's May 2008 Federal Columbia River Power System biological opinion. The BiOp includes a "reasonable and prudent alternative" that describes operational improvements and off-site mitigation actions, such as habitat improvements, that would be implemented to improve fish survival and avoid jeopardy. Judge Redden is concerned about the adequacy and uncertainty of habitat provisions in the FCRPS BiOp: "*The most serious flaw in it is the habitat and in particular the estuary habitat…*"

Under a recently negotiated MOA between federal action agencies and the state of Washington, WDFW will lead efforts to identify and rank the priority of potential habitat enhancement actions from the mouth of the Columbia River to Bonneville Dam including lower tributary reaches having tidal influence. WDFW and partners will then sponsor on-the-ground projects -- funded by BPA and the U.S. Army Corps of Engineers (Corps) -- to protect and restore estuary habitat used by 13 species of anadromous salmon and steelhead listed under the auspisces of the ESA. The initial proposed list of new projects

[6] For the 2008 NOAA Fisheries FCRPS BiOp, the "estuary" is defined as the reach from the mouth of the Columbia River to Bonneville Dam including lower tributary reaches having tidal influence.

(coded yellow) – along with ongoing LCREP habitat restoration projects is illustrated in Figure 2.

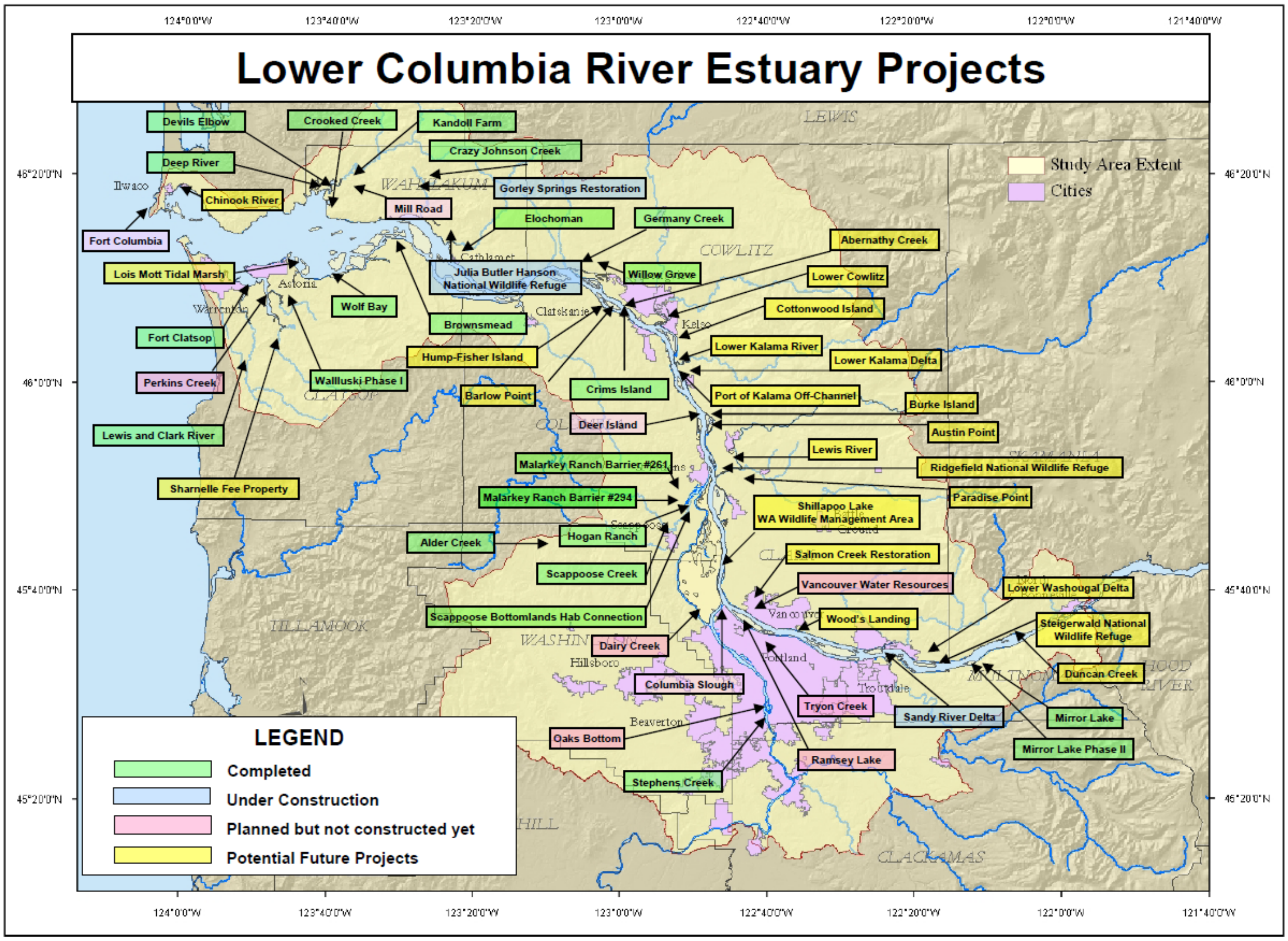


Figure 2. Estuary habitat restoration projects – completed, under construction, planned for 2009, and potential future projects for 2010 and beyond (Source USACE April, 2009).

The WDFW "estuary MOA", announced April 3, 2009, would almost double the amount spent on estuary habitat restoration – an additional $40.5 million ($4.5 million annually) during 2010-2018 – with a goal of significantly enhancing survival of listed stocks of anadromous salmon and steelhead listed under the ESA. The MOA takes advantage of Corps cost-sharing programs for habitat improvements. The WDFW will apply BPA funds, provided by ratepayers, to leverage matching federal appropriations for its 536 Program, which the Corps will seek from Congress.

The WDFW Estuary MOA contract with BPA will fund a coordinator position for WDFW (0.5 Full Time Equivalent (FTE)) plus 1 FTE each for WDFW and LCFRB to work collaboratively with LCREP and all relevant partners to identify and sponsor high impact projects for submittal to the Corps 536 Program[7]. Therefore, WDFW will be in an excellent position to coordinate the habitat project selection criteria, and the lists of high priority new, ongoing, and completed projects – as candidates for integration with the chum enhancement Project 2008-710-00 restoration and supplementation efforts.

Response to General Comment #4 Definition of Terms

In several places, the ISRP questioned the context or definition of technical terms that WDFW used in the chum salmon enhancement proposal.

Adaptive Management

In ISRP Request #6, the ISRP states that "adaptive management" as defined by *Walters, Hilborn et al.* is an "experiment".

In this document, WDFW will also provide definitions of Adaptive Management in the context of ESA Recovery Plans and the Council's Fish & Wildlife Program. The following definition is relevant to ESA Recovery Plans (NMFS 2007):

> *"Adaptive management is the process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends are proposed, prioritized, and implemented when necessary."*

Reintroduction and Supplementation

In ISRP Request #7, the ISRP requests "a clearer description of what is the reintroduction aspect versus the supplementation aspect of the proposal" and the ISRP introduces the term "*true supplementation*" – without providing a definition;

We use the term **reintroduction** in the context of a Recovery Goal for LCR chum in habitats that they have been functionally extirpated.

We define **supplementation** as an implementation strategy to achieve the goals of reintroduction and recovery.

[7] The BPA-WDFW estuary MOA funding is expected to be authorized in June 2009.

Artificial production is a tool that can be used in various ways to implement a supplementation strategy.

Small et al. (2009 Manuscript) provides the following description of supplementation[8]:

> *'Fisheries managers are shifting towards supportive breeding or "supplementation" hatcheries as a means to boost population abundance in threatened populations while minimizing risks from domestication (Ford 2002; Goodman 2004). In supplementation programs, hatchery brood stocks are drawn from a portion of in-river spawners and the offspring are raised in hatcheries for release into the wild. Upon return, some or all hatchery-origin offspring are allowed to spawn in natural spawning areas. Incorporating more spawners adapted to natural conditions into hatchery brood stocks is hypothesized to lessen overall domestication selection in the population in comparison to using hatchery-origin brood stock (Lynch and O'Hely 2001; Ford 2002; Araki et al. 2007)."*

Refer to WDFW Specific Response #7b for more detail; the decision tree (Figure 9) – illustrates under what conditions supplementation strategies would be implemented.

Effectiveness Monitoring

In the ISRP's discussion of the "**M&E (section G, and F)",** the reviewers question definition of the term "effectiveness monitoring" (p. 7 and p. 19); and the terms "primary" and "core" populations in Table 4 (p. 8).

WDFW considers these terms as common usage in ESA Recovery documentation (e.g., NMFS 2007), and specifically in the LCFRB Recovery Plan (2004).

Effectiveness monitoring evaluates whether the management actions achieved their direct effect or goal. Success may be measured against "reference areas," "baseline conditions," or "desired future conditions." Effectiveness monitoring can be implemented at the scale of single actions, suites of actions across space, or for an entire strategy consisting of a diversity of actions in a single place.

In the example of exclusionary fencing protecting a riparian area, the effectiveness monitoring indicators would be an assessment of the project's effect on the riparian habitat, given that the project was properly implemented and in compliance with

[8] Small, M.P., Currens, K., Johnson, T.H., Frye, A.E., and J.F. Von Bargen. (unpublished manuscript) Impacts of supplementation: Genetic diversity in supplemented and unsupplemented populations of summer chum salmon (Oncorhynchus keta) in Puget Sound (Washington, USA) Molecular Genetics Laboratory, Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA, 98502, USA

expected impact. Thus an appropriate metric would be riparian vegetation recovery, since this is expected to be an effect of excluding livestock from the riparian corridor. (Refer to Attachment 1.1; Source NMFS 2007).

“Primary”, “Contributing” and “Core” populations

The Lower Columbia Fish Recovery Board (Anonymous-LCFRB 2004 p. 5-7):

> *“Primary populations are those that would be restored to high or “high+” viability. At least two populations per strata must be at high or better viability to meet recommended TRT criteria. Primary populations typically, but not always, include those of high significance and medium viability. In several instances, populations with low or very low current viability were designated as primary populations in order to achieve viable strata and ESU conditions. In addition, where factors suggest that a greater than high viability level can be achieved, populations have been designated as High+. High+ indicates that the population is targeted to reach a viability level between High and Very High levels as defined by the TRT.”*

The FORUM framework document (Crawford [ed.] 2007):

> *“Primary populations are those that must demonstrate low risk of extinction in order to recover the MPG and ESU. The FORUM has developed this statewide Framework that identifies a set of the most important populations, including at least one from each MPG, for monitoring. In total, the salmon framework identifies a cumulative total of 28 major population groups containing a total of 86 primary populations for chinook, coho, chum, and steelhead.”*

The Hatchery Scientific Review Group Columbia Basin Review (Anonymous-HSRG 2008c):

> *“…populations of the highest biological significance…”*

Contributing Populations:

The Lower Columbia Fish Recovery Board (LCFRB 2004; p. 7):

> *“Populations for which some restoration will be needed to achieve a stratum-wide average of medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery.”*

Core Populations:

This term is used to categorize a population by its historical abundance and productivity, and is not related to its current status. McElhany et al. (2006 p. 10) states:

> "Within a stratum, the populations restored/maintained at viable status or above should be selected to: a. Allow for normative metapopulation processes, including the viability of ***"core" populations***, *which are defined as the historically most productive populations*." [our emphasis]

Earlier, McElhany et al. (2003 p. B-1) elaborated:

> "***Historically***, each evolutionarily significant unit (ESU) was characterized by a number of populations that represented the ***substantial portion of the ESU's abundance or contained life history strategies that were specific to the ESU***. These ***core populations*** are important components to maintaining the evolutionary legacy of the ESU. The Willamette Lower Columbia Technical Recovery Team (WLC-TRT) concluded that recovery agencies consider giving priority to these core populations in developing their recovery plans. In addition to sustaining the evolutionary legacy of the ESU, these core populations may offer the most likely path to recovery. If ***these populations sustained large populations historically***, they may have the intrinsic capacity to sustain large populations into the future."

We will provide a Glossary of Terms in this response document (Appendix 1) and also attach a succinct Glossary to our revised proposal (Attachment 1) to ensure that we are communicating effectively with the ISRP and other reviewers.

Response to seven specific "areas (that) require further justification or information"

ISRP Request #1. Provide more specific information on factors shown to cause declines in Lower Columbia River chum salmon.

Original Abundance of Chum Salmon in the Columbia Basin

Estimates of the pre-development level of total anadromous salmonid adult spawning run size in the Columbia River have varied widely – from 6.2 to 16 million fish per year (Table 1). The methodology used by Chapman (1986) probably provides the best estimates; i.e., an annual run size of 7.5 to 8.9 million salmonids during 1880-1920.

Table 1. Estimates of the pre-development level of total abundance of anadromous salmon and steelhead adults; and tribal catches.

Abundance	Reference	Basis
Abundance of Salmon and Steelhead (Number of adult spawners)		
10-16 Million	NPPC (1986)	Historical levels/ Aboriginal use
7.5 to 8.9 Million	Chapman (1986)	Commercial catches and exploitation rates, 1880-1920
6.2	PFMC (1979)	Pre-development Habitat Availability (salmon)

Chapman (1986) estimated the peak period runs of Columbia River chum salmon at 449,000 to 748,000 adult spawners during 1915-1919. This corresponds to a relative abundance of about 6 percent of the total salmon and steelhead run size in the Columbia Basin. Chapman (1986) states that his chum salmon abundance estimate is probably low since chum salmon were produced in small streams in the lower Columbia and their habitat may have been reduced by logging and other activites by 1915.

Factors for Decline

Factors for Columbia River chum salmon decline in the broad "all-H" context are similar to other anadromous salmonid species, except hatcheries have had relatively negligible impacts on chum salmon in the Columbia River compared to other species:

- **Harvest** (directed and incidental),
- **Hydropower** (Federal Columbia River Hydropower System, FCRPS),
- **Habitat** (tributary and estuary), and
- **Hatcheries** (Hatchery chum populations are less likely to be affected by domestication given their short-term culture (HSRG 2008a)[9].

These major categories of causes for decline have changed in importance over time for LCR chum salmon (Table 2). The chronology of changes of specific impacts in Table 2 is qualitative; however, a discussion with more quantitative facts will be presented in the following sections of this response document.

[9] Over the past decade, two hatchery conservation programs have operated for chum salmon in the Columbia Basin: Grays River/Chinook River in the Coast stratum, and Duncan Creek (currently un-funded) in the Gorge stratum.

Table 2. Effects of major causes for decline of Columbia River chum salmon over time: 1860's to present and future.

Time Period	Directed Harvest	Incidental Harvest	Hydropower (FCRPS)	Habitat (tributary & estuary)	Hatcheries – Artificial Production
Prior to 1865	negligible	negligible	none	Low impact	none
1866-1892	negligible	negligible	none	Low Impact	none
1893-1936	High impact (Craig and Hacker 1940)	negligible	none	Medium impact	negligible
1937-1955	High Impact (WDFW/ODFW 2002)	Low Impact	High impact (Bonneville 1938)	Medium impact	Low Impact
1956-1965	Medium Impact	Low Impact	High impact (The Dalles 1957)	Medium impact	Low Impact
1965-1998	Low impact	negligible	High impact	High impact	Low impact
1999 to present[10]	negligible	negligible	High impact	High impact	negligible to Low impact
Future Decade	negligible to Low impact	negligible	High impact	High impact	negligible to Low impact

Anthropogenic Impacts

Many human-caused factors can adversely affect anadromous salmonid survival and production during the life cycle; including:

- Withdrawal of water from the river for irrigation or municipal water supply (reducing water quantity); and juveniles lost to unscreened or inadequately screened pumps and diversions.
- Man-made dams and reservoirs in the lower river that inhibit, delay, or block adult upstream migrations or divert or disorient downstream juvenile migrations.
- Culverts, irrigation diversions, ineffective passage facilities, and other in-stream obstructions that delay or block fish movements and migrations.
- Loss of spawning and rearing habitats through dyking and channelization.
- Water pollution caused by agricultural return flows (pesticides and fertilizers), industrial effluents (toxicants) or domestic sewage (excessive nitrogen and phosphorous) in the riverine environment.
- Increased erosion, turbidity and sedimentation – along with altered temperature and hydrologic conditions – caused by alteration of riparian vegetation, logging, construction, road building, agriculture or other watershed activities.

[10] Columbia River Chum salmon were listed as "threatened" under the ESA in 1999.

- All of the pollutants and suspended sediments that enter the tributaries and rivers eventually end up in the environment and food webs of the mainstem lower Columbia River, the estuary, and the offshore plume.
- Changes in stream migration routes and obstructions, water temperature, flow patterns, and chemical composition that would affect returning salmon's homing behavior and physical ability to return to natal streams.
- Physical disturbance of the streambed, channelization, dredging, or removal of sand & gravel.
- Introduction of invasive/exotic species; including resident fish species (walleye, bass, catfish) that are predators on salmonid juveniles.
- Construction of reservoirs or in-river structures or creation of dredge-spoils islands that create habitat or increase reproduction and population size of predator species (fish, birds and/or mammals).
- Upriver storage reservoirs in the upper river that change the shape of the seasonal hydrograph and volume of flow.
- Direct mortality of adults for hatcheries, harvest, and illegal take (poaching).
- Mortality of juveniles due to predation by and competition with hatchery-produced salmonids, and mortality caused by illegal harvest in "trout" fisheries and other forms of illegal take (e.g., unscreened irrigation and small hydropower diversions).
- Loss of genetic fitness due to hatchery domestication.
- Reduction of marine derived nutrients in tributaries due to decreases in spawning run sizes; and reallocation of marine derived nutrients to mainstem areas via the long-term shift of biomass from anadromous salmonids to American shad.

Brief Review of Chum Salmon Biology – Relative to Limiting Factors

River habitat conditions and human activities affect the migration, spawning, and reproductive success of anadromous salmon. Water quantity (volume and hydrograph) and quality (e.g., temperature and chemical composition) are major factors that affect salmon production. In Japan, chum salmon first enter streams when temperatures drop to 15^{o} C and most enter when temperatures are $10\text{-}12^{o}$ C; the peak upstream migration occurs when the temperatures are $7\text{-}11^{o}$ C (Salo 1991). Chum salmon are stimulated to migrate upstream by any increase in stream runoff, e.g., a freshet following a rain storm. Chum salmon deposit their eggs in nests (redds) dug into submerged gravel bars that are porous and have sufficient interstitial water flow to ensure adequate oxygen supply. Chum salmon in Columbia River tributaries build redds in clean gravel of intermediate size: a low proportions of silt and sand (6%) and a low proportion of large cobbles, i.e., only 13% of the substrate was more than 15 cm in diameter (Burner 1951). When the percentage of fines and sand is 22% or more in redds -- the survival of chum salmon eggs was found to be less than 50% (Rukhlov 1969).

Chum salmon eggs are laid in a cone shaped hollow in the gravel about 20-40 cm deep, with a porous layer of stones around the bottom portion (Salo 1991). Based on survival of incubating eggs to emergence, Bruya (1981) concluded that spawning gravel depth should be a minimum of 30 cm, and egg deposition at depths of 40 cm is optimal. High egg mortality and premature emergence of fry occurs in redds less than 20 cm in depth.

Observations at over 1,000 redds in Washington State, indicated that 80% of the chum salmon spawned at velocities of 21.3-83.8 cm/s (mean= 50.3 cm/s) and at depths of 13.4-49.7 cm, with a mean 27.1 cm (Johnson et al. 1971). In Japanese streams, autumn run chum salmon select velocities of 10-20 cm/s and depths of 20 to 110 cm for spawning (Sano and Nagasawa 1958).

Limiting Factors for Chum Salmon in the Lower Columbia River

The cumulative effects analysis of the NOAA Fisheries FCRPS Biological Opinion (NMFS 2008, Section 8.9) summarizes the key limiting factors for Columbia River Chum salmon (see Appendix 4 for details). The following list of factors is ranked from most limiting to least:

1. Mainstem Hydropower impacts are significant, especially on the Gorge populations;
2. Estuary habitat degradation is an important limiting factor for all chum populations – refer to NMFS (2006);
3. Reduced tributary stream habitat function and wide-spread watershed degradation;
4. Predation impacts (birds, fish and mammals) are unknown and probably vary by location;
5. Effects of reduced marine derived nutrients (salmon carcasses) in chum salmon spawning areas is unknown; but assumed to be less in lower reaches of streams (chum salmon habitat) compared to the more oligotrophic upper stream reaches utilized by other salmonids;
6. Ocean conditions and climate change is assumed to be neutral for the near term, but is uncertain for the long term;
7. Historical and current hatcheries practices have not been a limiting factor; and
8. Currently, direct harvest impacts are negligible and indirect fishery mortality is very low.

The LCR Recovery Plan (LCFRB 2004; Chapter 3) summarizes the limiting factors and ongoing threats to salmon, steelhead, and trout species. Limiting factors are described in relation to the biological needs of the species, and the threats are those activities that lead to the limiting factors. By identifying the threats to recovery, specific recovery strategies and measures can be developed which would guide actions at the subbasin level to mitigate the threats. Limiting factors and threats for salmon and steelhead are described under the broad categories of stream habitat, mainstem and estuary habitat, hydropower, harvest, and hatchery operations. Species averages of currently available habitat (compared to historical) range from a low of 23% for chum to a high of 74% for summer steelhead. Chum salmon have a relatively high potential for benefits from habitat restoration since these percentages describe the scope for potential improvement and the relative scale of habitat degradation for different species and subbasins (Table 3).

Table 3. Current habitat condition for chum salmon by ssubbasin relative to historical conditions. The current condition of stream habitat is expressed as a percentage of historical condition using the Ecosystem Diagnosis and Treatment (EDT) model and properly functioning condition (PFC) as defined by NMFS (1996). {Source LCFRB 2004}

Subbasin	Current Condition (% of Historical Chum Salmon Habitat)	Primary Limiting Factors
Grays/ Chinook	28	A. Loss of off-channel and side channel areas. B. Lower river segments – accumulations of fine sediments. C. Estuary Habitat – loss of connectivity
Elochoman / Skam	28	A, B, C (as above).
Mill /Abernathy /Germany	28	A, B, C (as above).
L. Cowlitz	14	A, B, C (as above).
U. Cowlitz	--	A, B, C (as above).
Cispus	--	A, B, C (as above).
Tilton	--	A, B, C (as above).
NF Toutle	--	A, B, C (as above).
SF Toutle	--	A, B, C (as above).
Coweeman	--	A, B, C (as above).
Kalama	27	A, B, C (as above).
NF Lewis	--	A, B, C (as above).
EF Lewis	30	A, B, C (as above).
Salmon	0	A, B, C (as above).
Washougal	18	A, B, C (as above).
L. Gorge	41	Hydropower Estuary Habitat
U. Gorge (Wind)	14	Hydropower Estuary Habitat
White Salmon	na	Hydropower Estuary Habitat
Average	***23***	

Note: "—" indicates that an historical population for the species and subbasin did not exist. "na" indicates that an historical population for the species was present in the subbasin, but EDT habitat analyses are not available.

Specific limiting factors for chum salmon include (LCFRB 2004; Chapter 3):

- Chum spawning habitat and coho winter rearing habitat have been particularly impacted by loss of off-channel and side channel areas.

- Historical chum and Chinook spawning sites on lower river segments are especially susceptible to accumulations of fines. Accumulations of fines near the mouths of streams entering the Columbia River upstream of Bonneville Dam have increased since dam construction.
- For species like chum and ocean-type fall Chinook salmon that rear in the estuary for extended periods, a broad range of habitat types in the proper proximities to one another may be necessary to satisfy feeding and refuge requirements within each salinity zone. Additionally, the connectedness of these habitats likely determines whether juvenile salmonids are able to access the full spectrum of habitats they require (Bottom et al. 1998).
- Flow also affects habitat availability for mainstem spawning and rearing stocks. Significant numbers of chum and fall Chinook spawn and rear in the mainstem and side channels of the Columbia downstream from Bonneville Dam. Flow patterns determine the amount of habitat available and can also dewater redds or strand juveniles (NMFS 2000c).
- While ocean conditions are affected by the Pacific Decadal Oscillation (PDO), the phenomenon also influences freshwater environments as well, as precipitation and temperature patterns on land are also affected by the PDO. The most recent PDO shift has been related to increases in production of pink, chum, and sockeye salmon in the North Pacific Ocean (Beamish and Bouillon 1993). Chum salmon have broad, offshore migration patterns that may extend as far as the Gulf of Alaska.

The Status of the Resource (SOTR) Draft Report (CBFWA 2009) summarizes and updates the factors for decline, limiting factors, and threats for recovery for all focal species that were documented in the Subbasin Plans developed through the NPCC subbasin planning effort completed in 2004. These limiting factors, by life stage, for chum salmon in subbasins of the Gorge and LCR-Estuary Provinces are presented in Table 4.

Table 4. Limiting factors for chum salmon and life stage most effected (CBFWA 2009).

Factors for Decline / Limiting Factors / Threats		**Cowlitz**	**Grays**	**Kalama**	**Lewis**	**Wash-ougal**	**Little White Salmon**	**Wind**
Habitat	Estuary and Nearshore Marine Habitat Degradation	Smolts	Smolts	Smolts	Smolts	Smolts	Smolts	Smolts
	Floodplain Connectivity and function	Fry	Adults	Fry				
	Channel Structure and Complexity	Eggs, adults	Eggs, fry, adults	Fry, adults	Adults	Adults	Fry	Adults
	Riparian Areas and LWD Recruitment	Adults	Adults	Fry, adults	Adults	Adults		
	Stream Flow	Eggs, adults	Fry	Eggs, fry, adults	Eggs, adults	Adults		
	Water Quality	Eggs	Eggs	Eggs, fry, adults	Eggs, adults	Eggs	Fry	All
Hydro	Mainstem CR Hydro power adverse effects						Juveniles	Smolts
Hatchery	Hatchery-Wild Interbreeding	*Adult spawners	Adult spawners					
Predation / Competition / Disease	Pathogens	Eggs, adults		Adults				

* Note: Hatchery-Wild adult spawners interbreeding in the lower Cowlitz River is unlikely since there is no chum hatchery production in that system.

Estuary and nearshore marine habitat degradation – impacting smolts – was the most consistent limiting factor identified in the subbasin plans. The following potential limiting factors were not identified as a problem for chum salmon populations in any of the relevant plans:

- Harvest Mortality: targeted fishery (or incidental catches);
- Hatchery: Competition with hatchery smolts; and
- Predation / Competition: predation by or competition with non-native species.

Limiting Factors in the Oregon Coastal Chum Stratum

ODFW (2009) considers the primary limiting factors and threats to chum salmon in Coastal stratum populations identified in Oregon's Recovery Plan to be:

- alteration of estuarine habitats and ecological conditions affecting juvenile rearing and survival,
- excess fine sediments in spawning gravels,
- and predation on chum fry by hatchery fish in Youngs Bay.

Predation on chum fry by hatchery coho is identified as a potential limiting factor in Young's Bay (ODFW 2009). Hatchery coho programs have been conducted in this area since the early 1900's. In 2007 alone, almost 1.3 million hatchery coho smolts were released into Young's Bay as part of the Select Area Fishery (SAFE) program. The extent to which hatchery releases of coho salmon have affected chum salmon fry has not been evaluated.

Status and Temporal Trends of Chum Population Levels and Distribution

The National Marine Fisheries Service (NMFS) listed Lower Columbia River (LCR) chum salmon as threatened under the Endangered Species Act (ESA) in March 1999 (64 FR 14508, March 25, 1999). The listing was in response to the reduction in abundance from historical levels of more than one-half million returning adults to fewer than 10,000 present-day spawners (Johnson et al. 1997).

The estimated minimum run size for the Columbia River ESU has been relatively stable, although at a very low level, since the run collapsed during the mid-1950s (WDFW/ODFW 2002). Current abundance is probably less than 1% of historical levels, and the ESU has undoubtedly lost some (perhaps much) of its original genetic diversity (NMFS 2000; FCRPS BiOp Appendix C). Average annual natural escapement to index spawning areas was approximately 1,300 fish from 1990 through 1998 (ODFW and WDFW 1999).

Prior to 1997, only two chum salmon populations were recognized as genetically distinct in the Columbia River, although spawning had been documented in many Lower Columbia River tributaries. The first population was in the Grays River (RKm 34), a tributary of the Columbia River, and the second was a group of spawners utilizing the mainstem Columbia River just below Bonneville Dam (RKm 235) adjacent to Ives Island and in Hardy and Hamilton creeks (Johnson et al. 1997). Using additional DNA samples, Small et al. (2004) grouped chum salmon spawning in the mainstem Columbia River and the Washington State tributaries into three groups: the Coastal, the Cascade and the Gorge. The Coastal group comprises those spawning in the Grays River, Skamokawa

Creek and the broodstock used at the Sea Resources facility on the Chinook River. The Cascade group comprises those spawning in the Cowlitz (both summer and fall stocks), Kalama, Lewis, and East Fork Lewis rivers, with most thought to support unique populations. The Gorge group comprises those spawning in the mainstem Columbia River from the I-205 Bridge up to Bonneville Dam and those spawning in Hamilton and Hardy creeks.

Oregon Tributaries

All of the historical Oregon side populations in the lower Columbia River are considered functionally extirpated (ODFW 2005; McElhany et al. 2007; ODFW 2009). Based on the TRT analysis, the Oregon portion of the Columbia River chum ESU historically contained 8 populations located within the Coastal, Cascade, and Gorge geographic strata (McElhany et al. 2004). Coastal stratum populations include Young’s Bay, Big Creek, Clatskanie, and Scappoose; Cascade stratum populations include Clackamas and Sandy; and the Gorge stratum includes Lower and Upper Gorge populations which occupy both the Oregon and Washington sides of the Columbia and corresponding tributaries.

Washington Tributaries

Bryant (1949) summarized salmon fishery and stream survey data from the 1930’s and 1940’s and concluded that the major chum populations historically occurred in “Area I” – i.e., in Washington streams from the mouth of the Columbia River to and including the Klickitat River:

> “*Chum salmon seldom go more than 150 to 200 miles from the ocean to spawn. They usually make their first appearance in the Columbia River in October and proceed directly to the lower sections of the tributaries. This species is becoming more important to the commercial fishery as the other species are reduced in abundance and it is to be noted that Area 1 supports larger populations of chum salmon than does all the rest of the Columbia Basin combined.*”[11]

The Lower Columbia/Willamette Technical Recovery Team (TRT) has organized the Columbia River chum ESU into three geographic strata – each comprised of the following Washington-side populations:

1. Coast Stratum (Grays/Chinook, Elochoman, and Mill/Abernathy/Germany);
2. Cascade Stratum (Cowlitz, Kalama, Lewis, Salmon, and Washougal populations; and
3. Gorge Stratum (Lower Gorge, and Upper Gorge tributary populations).

---

[11] Area I in the Bryant (1949) stream surveys was Washington streams from the mouth of the Columbia River to and including the Klickitat River.

Most populations of the chum ESU are at "very high risk" of extinction (see Table 1 of our original proposal). The strongest LCR chum populations – Grays/Chinook, Elochoman, and Washougal – are at "high risk" of extinction. Only one lower Gorge population (Ives Area, just below Bonneville Dam) is considered to be in "medium risk" of extinction. The TRT also established population recovery designations for the chum salmon ESU (see Table 2 of our original proposal).

Current distribution of chum salmon in the Lower Columbia River is comprised of a few population centers (strongholds):

- Grays/Chinook population (Washington portion of the Coastal stratum),
- Duncan/Hardy/Hamilton/Ives Island population (Washington portion of the Gorge stratum)[12]
- and the Interstate 205 (I-205) spawning aggregation (Woods Landing and Rivershore areas) (Washington portion of the Cascade stratum).

The color coding provided in Table 5 provides a clear visual illustration that all existing chum populations or sub-populations in the lower Columbia River are either at critically low levels (yellow) or on a decreasing trend (orange). The intent of this table is to show the severely depleted condition of all LCR chum populations (and sub-populations) during the most recent years that we have data (i.e., 2002-2007). The underlying numerical data will be presented and discussed in a subsequent section – refer to our response to ISRP Request #7(a), Table 14. The relevance of examining the status of geographic sub-populations is that site-specific habitat restoration and supplementation strategies would also be implemented at this relatively fine spatial scale. The take-home message is that the current critically low levels of chum populations and sub-populations indicates the need for supplementation strategies to recover these stocks.

The HSRG (2008) concluded that the use of chum conservation hatchery programs should be viewed as an important short-term risk management strategy to preserve the genetic legacy of depressed chum salmon in the Columbia River. The HSRG further stated that hatchery intervention can reduce demographic risk by boosting abundance and additional conservation propagation programs should be promptly initiated within each of the ESU's three geographic strata to reduce this risk. The need for hatchery intervention has been recognized by NOAA Fisheries (2008 FCRPS BiOp).

[12] Ives Area chum are not genetically distinct from mainstem spawners at Multnomah Falls and Horsetail Falls Creek (Oregon portion of the Gorge stratum).

Table 5. Chum salmon abundance trends for Southwest Washington and LCR Tributaries, 2002-2007 (source: Todd Hillson and Julie Henning, WDFW). The color code key is: green: sub-populations that are on an increasing temporal trend; orange: sub-populations that are on a decreasing temporal trend; and yellow: sub-populations with critically low abundance.

River or Tributary	2002	2003	2004	2005	2006	2007
Grays River (Mainstem Grays, WF Grays, and Crazy Johnson Creek)						
Skamokawa Creekand Elochoman River						
Mill, Abernathy and Germany creeks						
Cowlitz and Coweeman rivers						
Kalama River						
Lewis and EF Lewis rivers						
The I-205 Area and nearby tributaries						
Washougal River and Lacamas Creek						
Mainstem- St Cloud						
Mainstem- Multnomah						
Mainstem- Horsetail						
Mainstem- Ives						
Bonneville Tributaries (Duncan, Woodward, Hardy, Hamilton and Greenleaf creeks)						

Key:

Increasing trend	
Decreasing trend	
Critically low	

The stronghold stocks were generally increasing in the early 2000's, but have exhibited decreasing trends in recent years, e.g., Figure 3 (I-205 population) and Figure 4 (Ives Area population). Based on statistically valid population estimates, the mainstem I-205 chum population[13] steadily decreased from about 3,468 in year 2002 to 626 spawners in 2008 (Figure 3).

[13] The I-205 chum salmon spawning area (and corresponding population estimate) consists of the Woods and the Rivershore areas (Todd Hillson, Personal Communication, April 20, 2009).

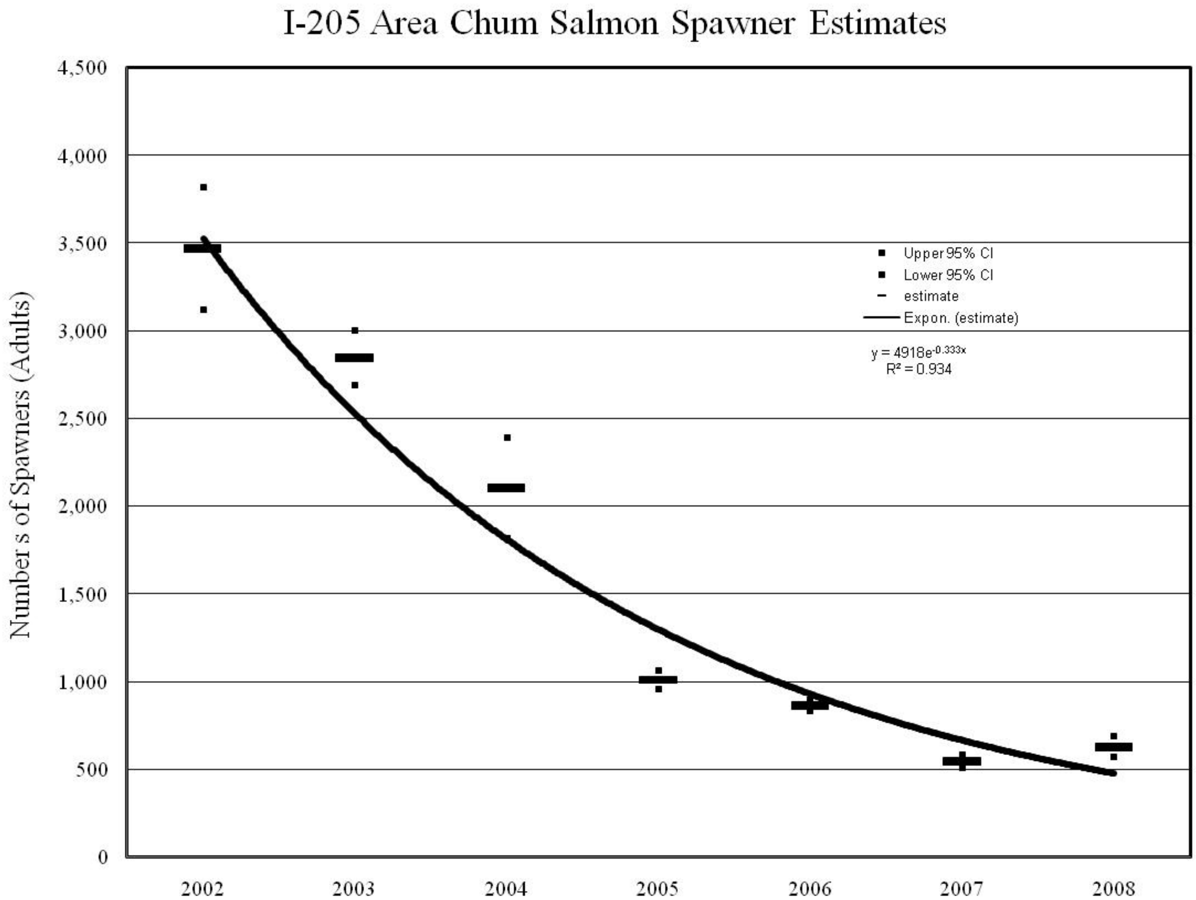


Figure 3. Population estimates of the I-205 (Woods Landing and Rivershore) adult chum population (Source Todd Hillson, WDFW).

The other major spawning region just below Bonneville Dam is the Ives Area; it consists of the mainstem Ives spawning grounds estimate, plus fish destined to spawn in the tributaries (i.e., Hamilton and Hardy creeks). This Ives composite spawning estimate also showed a significant downward trend from 2002 thru 2008 (Figure 4).

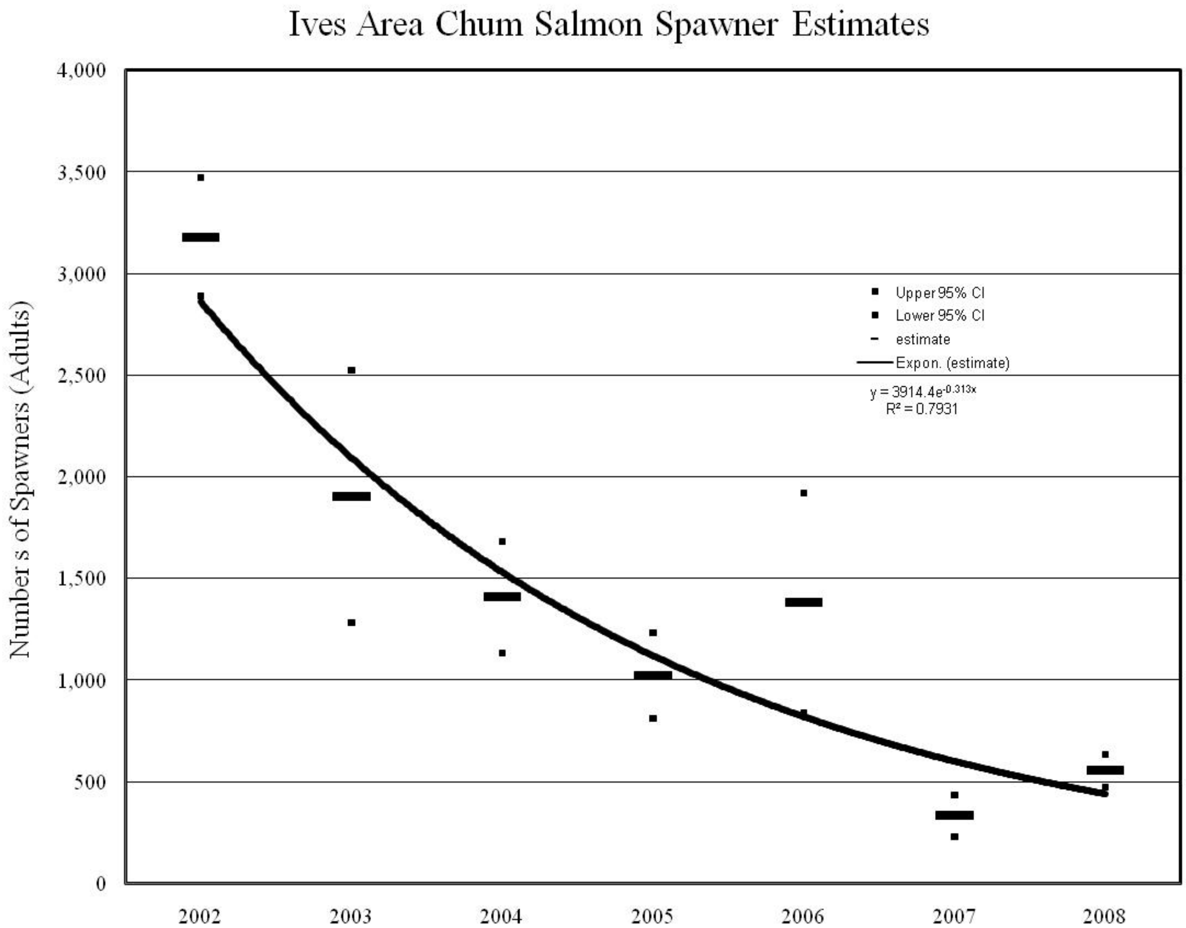


Figure 4. Population estimates of the Ives Area (mainstem Ives spawning grounds plus fish destined to spawn in the nearby tributaries) adult chum population (Source Todd Hillson, WDFW).

The Status of the Resource (SOTR) Draft Report (CBFWA 2009) summarizes and updates the recovery status of populations of chum salmon within the Columbia ESU (Table 6). It clearly stands out that many of the recovery metrics are unknown for Columbia River chum salmon. The current viability for all chum populations is considered to be “very low” – except for the Grays/Chinook population group.

Table 6. Recovery Status of ESA-listed chum (SOTR, CBFWA 2009)

Subbasin / Population	Abundance Threshold	Current Reference Abundance	Major Spawning Areas Occupied	Growth Rate	Recruits per Spawner	Current Viability
LCR and Estuary Province:						
Mill, Abernathy, Germany Ref 900, 901	Unknown	<100	--	--	Unknown	Very Low
Cowlitz Ref 905	Unknown	<300	Unknown	Unknown	Unknown	Very Low
Elochoman / Skamokawa Ref 905	Unknown	<200	Unknown	Unknown	Unknown	Very Low
Grays / Chinook Ref 905	1,120	1,570	--	Unknown	2.50	Moderate
Kalama	Unknown	<100	--	Unknown	Unknown	Very Low
Lewis	Unknown	<100	--	Unknown	Unknown	Very Low
Washougal	Unknown	<100	--	Unknown	Unknown	Very Low
Gorge Province:						
Upper Gorge – Little White Salmon	Unknown	Unknown	--	Unknown	Unknown	Very Low
Upper Gorge – Wind River	1,100	<50	--	Unknown	Unknown	Very Low

Summary of Habitat Impacts

The four previous sections – that discuss causes for decline, biological characteristics, limiting factors, and current status – have presented detailed data on the anthropogenic impacts on LCR habitat that have been significant factors for decline of chum salmon in the Columbia River ESU.

NOAA Fisheries (2008; Table 8.9.2.1-2.; Appendix 4) lists estuary and tributary habitat degradation as key limiting factors for Columbia River chum.

> *Estuary : The estuary is an important habitat for migrating juveniles from Columbia River chum populations. Alterations in attributes of flow and diking have resulted in the loss of emergent marsh, tidal swamp and forested wetlands.*

Habitat: Widespread development and land use activities have severely degraded stream habitats, water quality, and watershed processes affecting anadromous salmonids in most lower Columbia River subbasins, particularly in the low to moderate elevation habitats most often used by chum.

It is noteworthy that Craig and Hacker (1940) documented that hydropower, water diversions, and habitat degradation occurred early in the development of the region:

"… it must be remembered that under present conditions many miles of spawning streams have been cut off by dams so that they are no longer available to the migratory fish, that irrigation diversions take an enormous toll of the young migrants when they are on their way to the sea, and that pollution and other changed conditions have made many streams less suitable for salmon."

Likewise, Chapman (1986) observed that logging and habitat impacts had already reduced chum abundance prior to 1915 when commercial fisheries switched from more desirable salmon species to chum salmon.

Hatchery and Artificial Production Impacts

Hatchery fish have had little influence on the wild component of the CR chum salmon ESU (NMFS 2000 FCRPS BiOp Appendix C). NMFS estimates a median population growth rate (lambda) over the base period, for the ESU as a whole, of 1.04 (Tables B-2a and B-2b in McClure et al. 2000b). Because census data are peak counts (and because the precision of those counts decreases markedly during the spawning season as water levels and turbidity rise), NMFS was unable to estimate the risk of absolute extinction for this ESU.

Historically, chum salmon have been less directly impacted by hatchery operations in the Columbia Basin for two reasons:

1. Only a relatively low level of artificial production has occurred for this species in the Columbia Basin – probably because, as a food fish – chum is the least desirable anadromous salmonid species in the Columbia Basin; and
2. Hatchery chum populations are less likely to be affected by domestication given their short-term culture, i.e., released as fry (HSRG 2008a).

Hatchery production of other species in the Lower Columbia River could have contributed to the decline of chum salmon – through competition for food in the tributaries and estuary, predation on chum fry by larger 1-2 year old juveniles of other hatchery salmonid species, and possibly the inter-specific transfer of disease and parasites.

According to the WDFW/ODFW Status Report for 1938-2000 Columbia River Fish Runs and Fisheries (2002), the records of chum salmon returning to Columbia Basin hatcheries are generally not available prior to 1986. The total hatchery returns listed in Table 7 (column 2) are for Sea Resources hatchery (1986-1997), Abernathy Hatchery 1990, and Cowlitz and Elochoman Hatcheries (2000), and Cowlitz Hatchery 1997-present (WDFW/ODFW 2002). Note the returns to Cowlitz, Lewis, and Elochoman hatchery racks are natural origin fish – that are subsequently returned to the river since no hatchery program currently exists in these systems. Grays River hatchery return numbers include fish captured for broodstock in the mainstem and WF Grays River and Crazy Johnson Creek.

Table 7. Returns of adult chum salmon to Lower Columbia River tributary hatcheries (Source: Internet -- WDFW Annual Hatchery Escapement Reports or footnote citation).

Return Year	Total Hatchery Returns*	Cowlitz Salmon + Trout **	Lewis	Elochoman	Grays***
1986	100				
1987	100				
1988	300				
1989	200				
1990	1,200				
1991	200				
1992	900				
1993	3,000				
1994	700				
1995	500				
1996	300	8	0	0	0
1997	<100	8	0	0	10
1998	<100	27	0	0	0
1999	427	17	0	0	410
2000	582	3	1	0	578
2001	254	0	0	0	254
2002	365	2	1	0	362
2003	325	15	0	0	310
2004	316	8	0	0	308
2005	321	13	0	0	308
2006	142	8	2	4	128
2007	125	5	2	0	118
2008	143	5	0	0	138

* Source of total return data: WDFW/ODFW (2002) for the period 1986-98; summation for 1999 to 2008.
** Source of Cowlitz return data: Julie Henning, WDFW – for 2003 to2008.
*** Grays return numbers include broodstock captured in the mainstem Grays, WF Grays, and Crazy Johnson creek in addition to hatchery returns.

The historical influence of hatchery fish in the Grays River basin is small compared to other ESUs (NMFS 2000; FCRPS BiOp Appendix C). Hatchery-cultured chum salmon from Willapa Bay (i.e., Pacific Coast chum salmon ESU) were transplanted into the Chinook River (a tributary to Baker Bay in the Columbia River estuary) during the late 1980s. Initial returns from this transplant were close to a thousand fish per year, but more recent returns have been substantially lower (less than or equal to 20 fish per year during 1997 and 1998). In 1998, WDFW decided that non-native chum salmon should be removed from the system. Consequently, all Willapa Bay chum salmon returning to the Sea Resources Hatchery during 1999 were destroyed. The Sea Resources and Grays

River hatcheries are now used to culture Columbia River chum salmon for reintroduction into the Chinook River. Overall, the abundance of the Grays River population has increased since the mid-1980s, but appears to follow a cyclical pattern. The average population rate of growth was positive in the late 1990s (McClure et al. 2000), but the cyclical trend results in a high variability around the average estimate.

An HGMP has been completed for the Washougal Hatchery Chum Salmon Program (WDFW 2003). The Washougal Hatchery HGMP is a combination of the Duncan Creek reintroduction program and salvage plan for the Washougal and Lower Gorge populations. The goal of the Duncan Creek reintroduction program is to establish a self-sustaining population. This will be accomplished by a combination of juvenile supplementation and releases of wild chum salmon adults into renovated spawning habitat located in Duncan Creek. The goal of the salvage operation is to reduce the extinction risk of Lower Gorge and Washougal chum populations caused by hydropower operations. The approach used here is similar to that being employed for Duncan Creek supplementation. Wild adults will be captured and spawned at the Washougal Hatchery and progeny will be released into tributaries in those years when the Columbia River flow levels place this population at risk by limiting access to spawning areas.. Both programs have monitoring and evaluation components to evaluate the effectiveness of these strategies.

The NOAA Fisheries BiOp (May 21, 2007) Hatchery Proposed Actions recommends reintroduction strategies and implementation of chum supplementation programs:

> ***"Columbia River Chum Salmon***
> *Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation programs for chum salmon in selected Lower Columbia River tributaries below Bonneville Dam."*

Potential Hatchery Impacts in Oregon Tributaries:

Currently chum salmon are considered to be functionally extirpated in Youngs Bay tributaries; however, if chum were reintroduced as proposed by the ODFW (2009) conservation plan the impacts of hatchery-produced coho salmon could become an issue. Hatchery coho programs have been conducted in the Youngs Bay subbasin since the early 1900's. In 2007 alone, almost 1.3 million hatchery coho smolts were released into Young's Bay as part of the Select Area Fishery (SAFE) program. The extent to which hatchery releases of coho salmon have affected chum salmon fry has not been evaluated in the Youngs Bay system.

Hydropower Effects on Chum Salmon

The Columbia River hydropower system – especially Bonneville and The Dalles Dams -- affects chum salmon in three primary ways:

(1) Adult fish passage blockage – of all Pacific salmon and steelhead species, the chum salmon returning adults are least capable of ascending ladders at Columbia River dams;
(2) Spawning and rearing habitat in lower reaches of tributary streams above Bonneville and The Dalles was flooded – reducing production potential of the reduced number of chum salmon spawners able to pass the dams; and
(3) Chum fry disorientation in reservoirs, and increased fish passage mortality through turbines – results in greatly reduced survival and production of chum salmon above Bonneville Dam.

The cumulative impacts of these limiting factors over time have functionally extirpated Chum salmon from all production areas above Bonneville Dam; this happened gradually -- from the time of dam construction (1938) to present. Ongoing threats to salmon from hydropower obstructions and delays include (LCFRB 2004):

- Passage obstructions – blocked spawning and rearing habitat,
- Inadequate passage facilities,
- Poor passage conditions (inappropriate flows), and
- Passage delays and mortality of juveniles and adults.

Additionally, flow level changes below Bonneville Dam associated with power generation can limit access to mainstem and tributary spawning areas in the Ives Island area,dewater existing redds, and affect transit time of juveniles from spawning areas to the Columbia River estuary.

Historical Information on effects of Columbia River Dam Passage Problems on chum salmon

The historical record in the Pacific Northwest shows that dams greater than about 10 m in height, including dams with fish ladders, generally block the upstream migration of adult chum salmon. Furthermore, reservoirs as small as one hectare blocks the downstream migration of juvenile chum salmon. Successful passage of adult spawners, however, has proven successful using conventional ladders at hatcheries -- where the ascent from the river to the hatchery is < 10 m. Most of these hatcheries are located in lower reaches of coastal rivers where tidal influence further decreases the length and rise of the fish passage facility on a daily basis, i.e., at high tides.

Salo (1991) makes the following observations on the swimming and jumping ability of chum salmon:

> "Chum salmon are large, strong swimmers and are capable of swimming in currents of moderate to high velocities. The maximum swimming speed recorded is 3.05 m/s or 67% of the maximum burst speed of 4.6 m/s (Powers

> and Osborn 1985). They are not leapers and usually are reluctant to enter long-span fish ladders. Thus they are usually found below the first barrier of any significance in a river."

MacKinnen and Brett (1955) described an experiment in which pink and chum salmon fry were released at the upstream end of a 2.4-acre impoundment in British Columbia (Cited by Andrew and Geen 1960). Only 25% of the pink and chum fry moved through the reservoir during a nine-day period when recapture gear was operated at the outlet. Since the fry of these species normally migrate directly to the sea after emerging from the gravel -- the very low recovery suggested a serious loss in the impoundment.

Successful Hatchery ladder designs – show chum salmon capabilities and limitations

Washington Department of Fish and Wildlife (WDFW) operates several successful chum salmon fish hatcheries in the Puget Sound Region that incorporate fish ladders and adult brood stock holding facilities. The Chambers Creek trapping facility (near the city of Tacoma) has two fish ladders on each side of a dam, with holding ponds at the top (Darryl Mills, WDFW Hatchery Manager, Personal Communication). The dam is located near tidewater and creates an impoundment of about 20 acres. The ladder steps are about 10 inches in height with a 6 inch sill. The rise from the creek to the top of the dam, at high tide, ranges from about 6 inches to 6 feet (depending on the strength of the tide). Chum salmon are strong swimmers (e.g., they can swim up an incline over a dam in 2 feet of water) but have very limited jumping ability. The Chambers Creek chum is a late stock that runs in mid-December. The chum salmon move into the facility on a freshet and high tide. Most of the spawners are 3-4 years of age, weigh 4-25 pounds, and are 24-36 inches in length. One interesting observation is that the female chum salmon use the ladder on one side of the dam and the males use the ladder on the opposite side of the dam.

WDFW uses pool and weir fishways for chum salmon hatcheries[14]. The ladder pools are 6 feet wide and 8 feet long, with 9 inch steps. The top log in the ladder is slotted on alternate sides, with 6 inch high by 24 inch wide notches. The minimum required water flow is the amount needed to keep the notch full, the optimum flow is 3 inches over the slot. The number of ladder steps is usually 20 to 25; and the maximum rise of 15-20 feet from the river to the hatchery. Fatigue is a factor for chum salmon; resting pools are needed if the rise is greater than 20 feet.

[14] The chum salmon ladder design information was obtained from Don Bartlett, a WDFW fisheries engineer (Steve Vigg, Personal Correspondence, October 1996).

Bonneville and The Dalles Dams Functionally Blocked Columbia River Chum Runs

The long-term decline in chum salmon runs began when Bonneville Dam (at river mile 146) was completed in 1938 (Figure 5). Since that time, spawning runs of chum salmon in the Columbia River past Bonneville Dam have continued to decline to very low levels; and chum salmon have been virtually eliminated past river mile 192 because of an effective passage block at The Dalles Dam (second mainstem dam built in 1957) -- see Table 8. This decline of chum salmon occurred even though the mainstem Columbia River Dams were built with adult fish passage facilities[15] and navigation locks that effectively pass four other species of Pacific salmon and steelhead.

Table 8. Counts of adult chum salmon migrating upstream past Bonneville and The Dalles Dams, Columbia River, during 1938-2008 (USACE 2009).

YEAR	5-year Average Count at Fish Ladders	
Interval	Bonneville Dam	The Dalles Dam
1938-1940	1,671.3	--
1941-1945	1,920.8	--
1946-1950	1,622.0	--
1951-1955	1,232.8	--
1956-1960	729.8	41.5
1961-1965	755.2	4.8
1966-1970	331.0	0.2
1971-1975	21.4	0.0
1976-1980	20.2	0.0
1981-1985	45.4	0.2
1986-1990	65.2	0.8
1991-1995	23.4	0.0
1996-2000	30.0	0.0
2001-2005	146.2	6.8
2006-2008	90.3	3.7

The relatively high mean numbers of chum passing Bonneville and The Dalles during 2001-2005 correspond to high redd counts and population abundance estimates of chum below Bonneville Dam during the early 2000's. The 2001-2005 mean value at Bonneville was skewed by an exceptionally high passage number during 2003, i.e., 411 chum salmon. This was the highest chum passage at Bonneville since 1966 when 872 adults passed over the dam.

[15] The Bonneville Dam fishway is comprised of three fish ladders consisting of pools 16 feet in length between transverse weirs, and a 1-foot drop between pools (i.e., a slope of 6.25%). The fish ladders range 1,225 to 1,337 feet in length and are situated on both sides of the river.

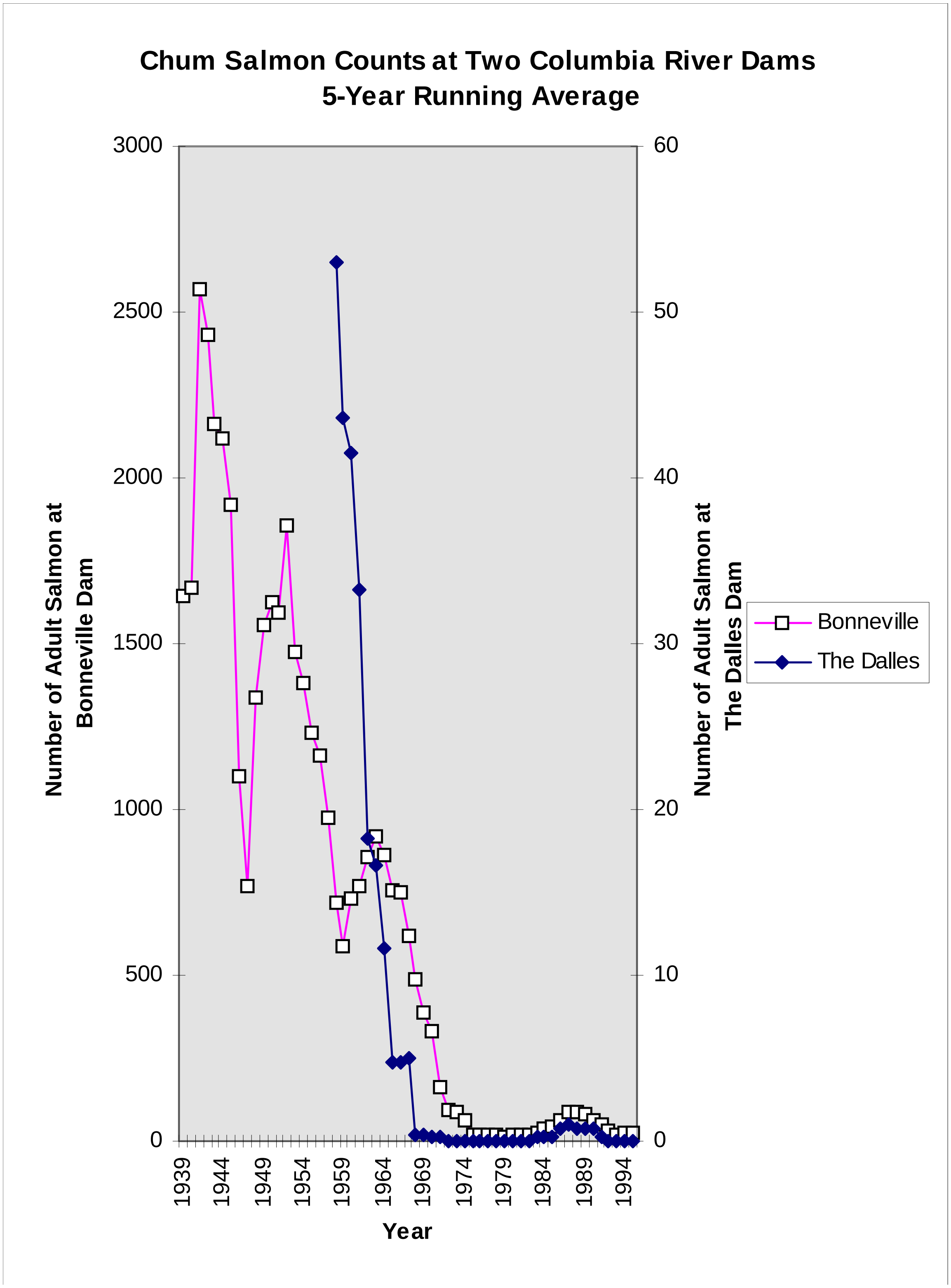


Figure 5. Numbers of chum salmon adults migrating over fish ladders at Bonneville and The Dalles dams, Columbia River, 5-year running averages 1938-1995.

The Columbia River dam passage facilities also enable the upstream migration of American shad (*Alosa sapidissima*) and Pacific lamprey (*Lampetra tridentada*); but effectively blocked adult sturgeon migrations (*Acipenser* spp.).

The maximum pool elevation of Bonneville Reservoir is 82.5 feet above mean sea level (msl) and the power head is 26 feet. Under normal operating conditions, fish ascend a rise of about 51 feet -- the difference between normal operating elevation (74 ft msl) and the tailrace elevation (23 ft msl).

Harvest Impacts

Historically, excessive in-river commercial harvest rates were a major cause of initial chum salmon run size declines prior to 1938. However, it was the construction of Bonneville Dam in 1938 that further depressed the chum spawning runs, and prevented the species from rebounding due to loss of productivity. Productivity was permanently depressed by loss of access to lower tributary spawning areas and rearing areas that were inundated by Bonneville and The Dalles Reservoirs and changes in the seasonal flow patterns below Bonneville Dam.

In-river commercial harvest contributed – as a cumulative effect (along with Hydro and Habitat) to the continued decline of chum salmon from 1938 to the 1950's. In 1942, over 425,000 adult chum salmon were taken in Columbia River commercial fisheries below Bonneville Dam, and it subsequently dropped below 10,000 fish harvested annually after 1955 (WDFW/ODFW 2002). Since the listing of chum salmon under the ESA in 1999[16], catches in the Columbia River sport and commercial fisheries is negligible; and harvest is currently not a limiting factor. Based on all accounts, ocean harvest has never been a limiting factor for Columbia River chum salmon.

Historical Chum Harvest Impacts

Craig and Hacker (1940) estimated that the pre-development (pre-1800) Indian consumption of salmon and steelhead was about 18 million pounds per year (Table 9); i.e., thus, it was comparable to the non-Indian commercial catch of 26 million pounds of salmon and steelhead in 1933. Based on average weight of all species (weighted by abundance) at least 1.2 million salmon were caught annually for consumption by native peoples[17]. Craig and Hacker (1940) explain why the Tribal catch was sustainable and the non-Indian commercial fishery was not:

[16] Columbia River chum salmon ESU listed as threatened effective May 24, 1999 (64 FR 14507).

[17] The catch number would be higher, if we adjusted it for wastage or use for other purposes; i.e., fish caught but not used for human consumption.

> *"Even though the primitive Indian catch might have been of some such magnitude as that estimated above, it did not represent as great a proportional strain on the spawning population as its relationship to the present catch would indicate. This is true because it must be remembered that under present conditions many miles of spawning streams have been cut off by dams so that they are no longer available to the migratory fish, that irrigation diversions take an enormous toll of the young migrants when they are on their way to the sea, and that pollution and other changed conditions have made many streams less suitable for salmon."*

Table 9. Total annual consumption of anadromous salmonids by Indians in the pre-development period, i.e., 1800 (Craig and Hacker 1940).

Harvest	Reference	Basis
18 Million pounds	Craig and Hacker (1940)	50,000 people eating 1 pound per day
15 Pounds Weighted Average	Chapman (1986)	Literature: Smith (1985); Beiningen (1976); Craig and Hacker (1940); Thompson (1951)
1.2 Million	calculated	Number consumed/ weighted mean weight (all species)

Craig and Hacker (1940) documented dip net catch data from Indian fisheries at Celilo Falls – collected by the Bureau of Fisheries during 1889 to 1892, and 1925 to 1934; chum salmon catches were only recorded for the later time period (Table 10). The total 14-year dip net catch during 1889-1925 was composed of 18.5 percent sockeye, 56.1 percent Chinook, 0.9 percent chum, 7.1 percent coho, and 17.4 percent steelhead.

Table 10. Catches of chum salmon in Indian dip net fisheries at Celilo Falls – collected by the Bureau of Fisheries during 1925 to 1934 (Craig and Hacker 1940, Table 11).

Year	Chum Catch		Total Pounds (all species)
	Pounds	Percent of Total	
1925*	342	0.9	36,927
1926	--	--	238,695
1927	--	--	54,572
1928	4,164	2.9	142,007
1929	8,027	2.0	402,031
1930	6,892	1.1	627,438
1931	31,186	3.7	842,007
1932	--	--	231,194
1933	1,246	0.1	851,630
1934	600	0.1	530,500

* Catches during 1925 were recorded only for the Washington side landings.

Craig and Hacker (1940) noted:

> *"The amounts of chum and silver salmon caught by the dip nets are small because the majority of the fish of these two species spawn in the tributaries below Celilo Falls and enter the river so late that most of the Indians have left the fishing grounds before the small part of the run which does reach Celilo Falls arrives there."*

Based on historical data, Chapman (1986) concluded that spring and summer Chinook made up virtually all the commercial harvest in the early-development period of about 1881-1885. The shifts in canned salmon products documented by Craig and Hacker (1940) shows that fisheries targeted and over-exploited the most favored species and stocks then changed over to the next most desirable and profitable in the following sequence (Table 11): (1) summer Chinook, (2) sockeye, (3) spring Chinook, (4) steelhead, and (5) coho. The least desirable salmon for food fish were fall Chinook salmon and chum salmon.

Chapman (1986) summarized the timing of peak Columbia River chum harvest:

> *"The peak 5 years for chum salmon catches were 1915-1919, reflecting a shift in interest from other heavily fished runs to less desirable species. The mean peak-period catch of 1.99 x 106 kg of chum salmon translates to about 359,000 fish annually."*

It is interesting that the highest peak catches of chum salmon on record for the LCR commercial fisheries actually occurred in 1941 (340,100) and 1942 (425,400) – just 3-4 years after Bonneville Dam was completed (WDFW/ODFW 2002). One could speculate that the passage delay or blockage created by Bonneville made the chum salmon stocks and production previously originating above Bonneville more vulnerable to fisheries below the dam.

Bryant (1949) summarized salmon fishery and stream survey data from the 1930's and 1940's; he also observed that the focus of commercial fisheries had changed to chum salmon during that time because of the depletion of the more desirable salmonid species:

> *"This species is becoming more important to the commercial fishery as the other species are reduced in abundance and it is to be noted that Area 1 supports larger populations of chum salmon than does all the rest of the Columbia Basin combined."*[18]

[18] Area I in the Bryant (1949) stream surveys was Washington streams from the mouth of the Columbia River to and including the Klickitat River.

Table 11. Estimates of the pre-development level of total abundance of anadromous salmon and steelhead adults (Chapman 1986).

Species (stock)	Period for Peak Harvest (sequence)	Peak Catch[19] (Million)	Probable Actual (Optimum) Harvest Rate	Peak Runs - Lower (Millions)	Peak Runs - Upper (Millions)	Relative Abundance (Percent)
Sockeye Salmon	1883-1889 (2)	1.915	85 (73)	2.253	2.623	29.5 - 30.2
Summer Chinook	1881-1885 (1)	1.700	85 (68)	2.000	2.500	26.8 - 28.1
Spring Chinook	1890-1895 (3)	0.400	80 (68)	0.500	0.588	6.6 - 6.7
Fall Chinook	1915-1919 (6)	1.100	88 (88)	1.250	1.250	14.1-16.8
Coho Salmon	1894-1898 (5)	0.476	85 (77)	0.560	0.618	7.0 - 7.5
Chum Salmon	1915-1919 (6)	0.359	80 (48)	0.449	0.748	6.0 - 6.8
Steelhead	1892-1896 (4)	0.382	85 (69)	0.449	0.554	6.0 - 6.2
Total	1881-1919	--	--	7.461	8.881	100%

The above quotation is also noteworthy because it documents that the Washington-side tributaries of the Columbia River – from the Pacific Ocean confluence to the Klickitat River – have historically been the major chum production area. This is still true today since most if not all of the Oregon-side populations have been extirpated (ODFW 2009).

Beginning in the mid-1950s, commercial catches declined drastically and in later years rarely exceeded 2,000 per year (NMFS FCRPS BiOp 2000; Appendix C).

Current Chum Harvest Impacts

Lower Columbia River fisheries management is coordinated with a number of ongoing Federal, Tribal and State plans and processes (Vigg and Dennis, editors 2009):

- The Fisheries Management and Evaluation Plan (FMEP);
- Hatchery Scientific Review Group (HSRG) review for the Lower Columbia Region;
- Hatchery and Genetic Management Plans (HGMPs);
- The Lower Columbia River Conservation and Sustainable Fisheries

[19] To calculate catch numbers from canning records in weight, Chapman (1986) used the mean weight of Columbia River salmon species in the late 1800's (from Smith 1895): 10.45 kg for summer Chinook, 3.18 kg for coho, 2.25 kg for sockeye salmon, and 4.68 kg for steelhead, 5.54 kg for chum salmon.

Management Plan;

- The Washington Statewide Steelhead Management Plan (SSMP); and
- The 2008-2017 *US v. Oregon* Fisheries Management Plan.

Chum salmon are present in the LCR and its tributaries from October through January. Columbia River fisheries that potentially cause incidental catches of chum salmon are late fall commercial fisheries targeting late stock hatchery coho and sturgeon. Through the *US v. Oregon* Compact process, chum impacts are limited by gear mesh size restrictions in sturgeon fisheries and by curtailing coho fisheries by November before significant numbers of chum are present.

Oregon closed targeted chum fisheries in 1992, and most Washington tributaries have been closed to chum salmon fishing since 1995. Annual catch, as reported incidental take in the late fall mainstem Columbia River fishery, was less than 50 fish from 1994-2000 (NMFS FCRPS BiOp 2000). Incidental catch of chum salmon in the mainstem lower Columbia River has remained low during 2002-2007 with ESA impact rates of 5% and a target rate of 2%.

The following data from the LCR FMEP (Vigg and Dennis, editors 2009) shows that the incidental chum catch reported from mainstem commercial fishery landings has remained low (Table 12). Further regulatory restrictions have been placed on tributary fisheries; seasons were specifically closed for chum salmon retention in the Cowlitz and Lewis Rivers through the North of Falcon Process in 2008.

Table 12. Reported incidental catch (landings) of lower Columbia River chum salmon populations in mainstem commercial salmon fisheries (Todd Hillson (WDFW) and Joe Hymer(PSMFC)).

Year	*Incidental Chum Catch – Commercial Landings*
2002	***12***
2003	***6***
2004	***90***
2005	***10***
2006	***3***
2007	***38***

In 1996, Congress passed the Sustainable Fisheries Act, which revised the Magnuson Act. The Pacific Fishery Management Council (PFMC) is one of eight regional fishery management councils established by the Magnuson Act. The PFMC is responsible for fisheries off the coasts of California, Oregon, and Washington. Sockeye, chum, and steelhead are rarely caught in the ocean fisheries under the jurisdiction of PFMC. Columbia River chum salmon are also rarely taken off Alaska (Table 13).

Table 13. Approximate annual exploitation rates (percent of total population harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls; data represent the 2001-2003 fishing period (LCFRB 2004).

Fisheries	Chum Salmon Exploitation Rate
AK/ Canada Ocean	0%
West Coast Ocean	0%
Col River Commercial	1.5%
Col River Sport	0%
Trib. Sport	1.0%
Wild Total	2.5%
Hatchery Total	2.5%
Historic Highs	60%

Even though no fisheries target chum salmon, fishing activities result in the following potential threats:

- Incidental catch in sport and commercial fisheries, and
- Poaching.

Chum Catch in Oregon Fisheries

Youngs Bay is the centerpiece of the Select Area Fisheries Evaluation (SAFE) terminal fisheries program managed by ODFW and WDFW. According to ODFW's 2005 Native Fish Status Report (ODFW 2005) and McElhany et al. (2007) chum salmon are now functionally extinct in Young's Bay. A few adult chum salmon still appear to enter Young's Bay and have been incidentally caught in terminal commercial fisheries in recent years (Kostow 1995; North et al. 2006); however, observations of chum in Oregon tributaries are currently rare. One adult chum was observed in the South Fork Klaskanine during a chum survey conducted in 2000 (Muldoon et al. 2001), and another one was observed during ODFW random coho surveys conducted between 2002 and 2007 (ODFW 2009). It is possible that adult chum salmon that have been recently observed within the Youngs Bay subbasin were strays from the Grays River.

The HSRG (2008) noted a potential fisheries management conflict relative to the "Primary" designation of the (extirpated) Youngs Bay chum populations:

> *"The HSRG reviewed options for chum conservation in the lower Columbia River in the context of conservation goals for other salmon and steelhead ESUs as well as the objectives of fisheries managers for Chinook and coho harvest. Based on this broader context, the HSRG notes that conservation goals for the chum population in the Youngs Bay tributaries (as a Primary population) may be in conflict with conservation and harvest goals for coho salmon in this area. Timing of intensive gill-net fisheries in Youngs Bay to fully harvest hatchery-origin coho overlaps with the return of adult chum salmon. Furthermore, the release of large numbers of juvenile Chinook and coho salmon from net pens in this area may also cause excessive predation on migrant chum fry. Other chum populations in the Coast stratum are more likely to achieve the status of a Primary population in a manner that is compatible with the managers' goals for Chinook and coho."*

ISRP Request #2. Describe in adequate detail how the proposed efforts will meld with similar activities of Oregon Department of Fish and Wildlife and other entities.

Washington Department of Fish & Wildlife Region 5 managers and staff have had ongoing communications with Chris Knutsen, Oregon Department of Fish & Wildlife (ODFW), lead on Coastal and Lower Columbia River chum salmon recovery efforts[20]. ODFW no longer conducts any Columbia River or Columbia River tributary surveys that specifically target chum salmon. However, late season salmon surveys, conducted by ODFW staff based in Corvallis, incidentally observe chum (e.g., late coho surveys in the Big Creek drainage).

ODFW has developed a conceptual Recovery Strategy – focused initially on the Oregon coastal strata, that includes Youngs Bay, Big Creek and Clatskanie River (ODFW 2009; Appendix 8):

> *"Oregon has decided to focus our recovery strategy in the Oregon portion of the Coastal stratum. We believe the basins in the Coastal stratum have been altered to a lesser extent by human development than basins in the other strata, and provide the best opportunity with fewer constraints to re-establish self-sustaining chum populations. As a result, this strategy document focuses on recovery efforts for the Coastal geographic stratum only. Oregon intends to use results from this program to inform decision-making regarding recovery of chum salmon into the Cascade and Gorge geographic strata in the future."*

We discussed the ODFW conceptual recovery strategy with Chris Knutsen (Personal Correspondence, May 5, 2009) – summarized below:

a) Identify a chum salmon donor population that could be used as broodstock for a supplementation program – probably from the Grays River, Washington stock;
b) Develop a locally adapted chum salmon broodstock, probably at Big Creek Hatchery;
c) Begin re-introducing chum salmon to selected coastal stratum streams as a first priority:
    i) recovery strategy will include one coastal stratum population to be monitored for re-colonization, and
    ii) one population targeted for reintroduction.
d) Begin re-introducing chum salmon to selected lower Columbia streams (as a secondary priority) at a later time;
e) Monitor and evaluate to adaptively manage the chum re-introduction and the supplementation program.

Currently this Recovery Strategy for chum salmon restoration in Oregon tributaries is at a conceptual stage and funding is not available for implementation. ODFW plans to

---

[20] Chris Knutsen, District Fish Biologist, ODFW - North Coast Watershed District, 4907 Third Street, Tillamook, Oregon 97141; Phone: 503-842-2741.

coordinate with WDFW at a more substantive level when funding is secured to implement the program. At that time ODFW and WDFW would develop an Inter-Agency co-management agreement to initiate the chum supplementation program (Chris Knutsen, ODFW, Personal Correspondence, May 6, 2008).

Given the information presented above, it is apparent that extensive coordination with ODFW on the WDFW LCR Chum Project is premature at this time – since chum are functionally extirpated from Oregon tributaries and ODFW is not currently implementing chum monitoring or restoration projects in the Lower Columbia River. When ODFW decides to begin implementation of its restoration strategy (ODFW 2009) and acquires funding, then WDFW will assist as requested, including the evaluation of the Grays River population as a possible donor stock.

ISRP Request #3. Describe the experimental design for Objectives 2 and 4 (stock status review, population monitoring). These objectives should precede any prescription or rehabilitation plans; i.e., assess limits to population growth, including harvest.

As stated in our original proposal, the experimental design for Objectives 2 (stock status review) and Objective 4 (population monitoring) will be developed in detail during the first year of the project. However, we will describe in this response – the general approach and conceptual framework WDFW will use to accomplish these tasks.

WDFW agrees that a thorough stock status assessment should precede development of prescriptive plans for population recovery. We have proposed that this assessment should include an updated genetic analysis, coupled with a review of historic and recent population abundance data to provide the most current information on LCR chum population structure. Results will guide selection of priority habitat restoration projects and development of a reintroduction/supplementation plan that identifies priority populations for recovery, and potential donor stocks for reintroduction/supplementation. We also believe a comprehensive population monitoring and evaluation (M&E) plan (includes status and trend monitoring for ESA recovery, and effectiveness monitoring for evaluation of habitat restoration projects and supplementation actions) is needed prior to **implementation** of prescriptive rehabilitation plans; however, we believe development of the M&E plan can occur concurrently to prescriptive plans as long as elements of each are well integrated. Figure 1 (Page 12 of this document) provides a schematic description of the sequencing of Year 1 activities that lead to the development of an Integrated Strategy for Chum salmon enhancement in the lower Columbia River. Our response to ISRP Request #4 (Figure 7) details a timeline for completion of these activities.

“Experimental Design” for Objectives 2 and 4

In the ISRP comments by Proposal Section for Objectives 2 and 4, and reiterated here in ISRP Request #3, additional information on experimental design is requested, and it is suggested that we “work with a specialist to develop a statistically valid design for population estimation (Objectives 2 and 4)”.

Objective 4 - For objective 4 (M&E plan development), it is our intent to develop a statistically valid “experimental design”, in the first year of the project. We believe it is premature to develop a final M&E program design prior to completion of the stock status assessment and existing supplementation program review, also proposed for Year 1 of the project, and we propose to develop the M&E plan concurrently to these reviews, integrating key results. In addition, Chapter 7 of the LCFRB (2004) Recovery Plan describes monitoring and evaluation needs for plan implementation and provides a framework for M&E plan development; however, it does not provide the level of detail needed for the chum enhancement integrated strategy and Adaptive Management –M&E Plan:

> *“This plan provides the framework for a systematic regional approach. It generally identifies what needs to be done and how to do it. It does not drill down into specific implementation details such as desired confidence levels, statistical power, data collection protocols, sample sizes, etc. These* ***details will depend on additional refinements to the monitoring, research, and evaluation elements of this plan that will be developed as implementation planning proceeds****. Refinements will be predicated on the availability of resources for conducting an integrated monitoring, research, and evaluation program.”*

Our M&E plan will be within the framework of an Adaptive Management conceptual plan consistent with the guidance provided by NOAA Fisheries Service for monitoring recovery of listed stocks (also refer to our response to ISRP Request #6). NOAA Fisheries has provided four documents detailing the need for various kinds of information for determining the status of anadromous salmonids listed under ESA:

- **Viable salmonid populations:** McElhany et al. (2000). NOAA Technical Memorandum NOAA Fisheries-NWFSC-42.
- **Habitat Restoration Monitoring:** NOAA Fisheries Service (2006).“Performance Goals, Measures, and Reporting Framework” (given to the states and tribes through the Pacific Coastal Salmon Recovery Fund).
- **Adaptive Management Framework for Monitoring:** NOAA Fisheries Service (2007) “Adaptive Management for ESA Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance”
- **Monitoring Recovery:** Crawford and Rumsey (2009). Guidance For Monitoring Recovery of Salmon and Steelhead Listed Under the Federal Endangered Species Act (Idaho, Oregon, and Washington). Draft – April 27, 2009. NOAA Fisheries Service – Northwest Region. 125 pages.

The Crawford and Rumsey (2009) document provides recommendations for monitoring VSP status and trends (see Appendix 3 for more details):

1. VSP Adult Spawner Abundance:

- Incorporate a robust unbiased adult spawner abundance sampling design that has known precision and accuracy.
- Monitor ratio of marked hatchery salmon and steelhead with an external adipose clip to unmarked natural origin fish in all adult spawner surveys.
- As a first step to improved data quality, calculate the average coefficient of variation for all adult natural origin spawner databases for ESA populations and provide that information to all interested parties.
- Collect adult spawner data with a coefficient of variation (CV) on average of 15% or less for all ESA populations.
- Conduct a power analysis for each natural population monitored within an ESU to determine the power of the data to detect a significant change in abundance.
- Utilize the protocols published in the American Fisheries Society Salmonid Field Protocols Handbook whenever possible in order to standardize methodologies across the region in evaluating population abundance.

2. VSP Productivity

- Develop at least 12 brood years of accurate spawner information as derived from cohort analysis in order to use the geometric mean of recruits per spawner to develop strong productivity estimates.
- Obtain estimates of juvenile migrants for at least one significant population for each major population group (MPG) within an ESU or distinct population segment (DPS).
- The goal for all populations monitored for juvenile migrant is to have salmon data with a CV on average of 15% or less and steelhead data with a CV on average of 30% or less.
- A power analysis for each juvenile migrant population being monitored within an ESU should be conducted to determine the power of the data to detect a significant change in abundance.

3. VSP Spatial Distribution

- Determine spatial distribution of listed species with the ability to detect a change in distribution of ± 15% with 80% certainty.

4. VSP Species Diversity

- As a short term strategy, utilize species distribution information and spawn timing, age distribution, fecundity, and sex ratios to determine status/trend in species diversity of natural populations.
- As a long term strategy, develop a baseline of DNA microsatellite markers based on single nucleotide polymorphism (SNPs), allozyme and DNA genotypes and phenotypes for each population within each MPG and ESU.

Figure 1 of the NOAA Fisheries Service (2007) Adaptive Management Framework and Monitoring Guidance document (our Figure 6 below) provides an illustration of how the VSP parameters and metrics (listed above) are incorporated into an Adaptive Management listing status decision framework.

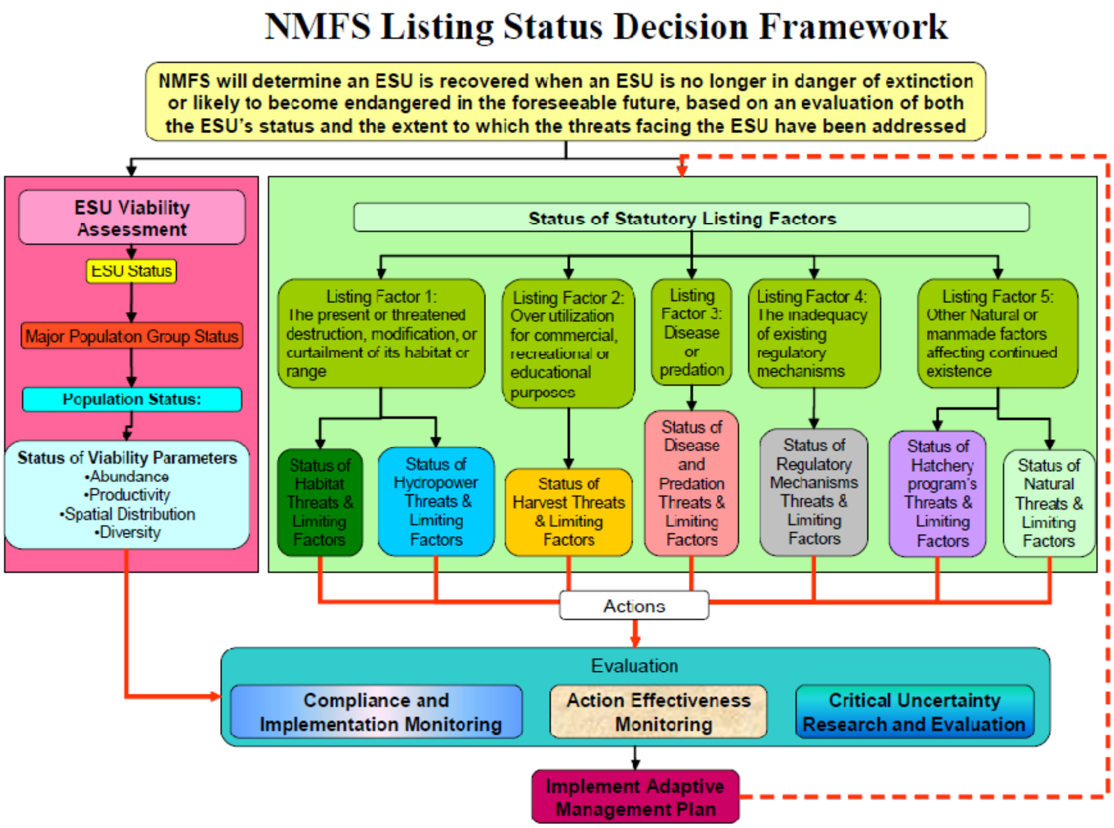


Figure 6. Illustration of the framework that links the M&E feedback from an Adaptive management plan the VSP parameters needed to evaluate the progress towards recovery relative specific causes for decline (source Figure 1 of NMFS 2007).

This Adaptive Management framework links enhancement actions and subsequent M&E – through an Adaptive Management feedback loop – to an ESU viability assessment of the VSP parameters and a review of the status of listing factors/causes for decline.

As stated in our original proposal, "*we propose to develop a comprehensive M&E program for LCR chum salmon populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/ reintroduction programs and habitat restoration actions.*" WDFW Science Division staff slated to assist in development of this plan are: Dr. Steven Schroder - leader of the Ecological Investigations Unit in the Science Division; Mr. Dan Rawding -lead agency scientist for salmon and steelhead population monitoring and salmon recovery in the lower Columbia River; Dr. Chris Ryding – biometrician, and Dr. Maureen Small – geneticist, WDFW Molecular Genetics Laboratory.[21]

[21] Resumes for key WDFW Science Division personnel were included in our original proposal.

As a Year 1 deliverable, we proposed to submit a draft of our comprehensive M&E-Adaptive Management Plan for the chum enhancement project – to BPA and the ISRP for review prior to implementation.

Objective 2 – The Lower Columbia/Willamette Technical Recovery Team (TRT) and the LCFRB (2004) Recovery Plan have outlined the historic population structure for LCR chum salmon and have assigned a recovery designation to each (refer to Table 4 of original proposal narrative).

The proposed LCR chum salmon stock status assessment to be completed in Year 1 is intended to answer three main questions:

1. What is the current genetic structure of chum salmon within these population designations? Which populations remain genetically unique, and functioning?
2. What is the current abundance of these populations?
3. How are existing supplementation programs contributing to the natural spawning population, both in-basin and out-of-basin (strays)?

The following components are proposed:

1. Processing of genetic tissue and otolith samples collected in 2003-08 (refer to Table 3 of original proposal narrative).
    1. Genetic tissue samples will be processed by the WDFW Molecular Genetics Laboratory following established protocols (Small et al, 1998).
    2. Otoliths will be processed and decoded by the WDFW Otolith Laboratory following established protocols (Volk et al 1999 and Brenkman et al 2007).

2. An updated analysis of LCR chum salmon population (genetic) structure.
    - Dr. Maureen Small (Geneticist, WDFW Molecular Genetics Laboratory) will perform an updated analysis of her previous work relating to LCR chum salmon genetic structure (Small et al, 2004 and 2006), using the newly acquired tissue samples described above.
    - Objectives are:
        i. identify and characterize genetic linkages between existing populations of LCR and other nearby (Oregon coast and Willapa Bay) chum salmon populations.
        ii. identify, based on genetic analysis, which existing populations could be used as broodstock for supplementation/reintroduction into streams where chum salmon have been or are nearly extirpated (potential donor stocks).
        iii. and identify which populations are genetically unique and functioning – for these, native broodstock is preferred for supplementation.

3. A review and update of historic and recent chum salmon abundance data.
    - Historic chum salmon abundance data is stored in a variety of forms: raw data (i.e. stream survey counts of live & dead fish, and redds), estimates of

fish per mile, peak index counts, estimates of abundance from peak count expansion.

- More recent abundance data has been generated using more robust estimation methodologies, primarily: Area-Under-the-Curve (AUC) and Jolly Seber Mark/Recapture [A detailed description of methodologies can be found in Rawding and Hillson (2003) and Rawding et al. (2006).]
- Mr. Dan Rawding (lead agency scientist for salmon and steelhead population monitoring and salmon recovery in the Lower Columbia River) and Dr. Chris Ryding (biometrician) of the WDFW Science Division Stock Assessment Unit will assist with this review.
- Objectives are:
    - i. Estimate annual chum salmon abundance with confidence intervals for LCR chum salmon (1940's to the present) in a standardized analytical framework.
    - ii. Develop annual estimates of stock origin, age composition, and sex ratios for LCR chum salmon populations.
    - iii. Report on chum salmon status relative to VSP and recovery plan goals.
    - iv. Storage of raw and summarized population data (WDFW SaSI, STREAMNET)
    - v. Highlight key assumptions for escapements (Strengths & Weaknesses Assessment)
    - vi. Develop sampling & analysis manuals, and tools for future escapement estimation.
    - vii. Integrate results with M&E program development to meet WDFW, LCFRB, NOAA, and BPA Fish & Wildlife Program goals.

4. A review of existing supplementation programs (i.e. Grays River and Duncan Creek) –
    - Chum salmon produced from each brood year of these supplementation programs have all been given a unique batch mark via thermal or strontium marking of the otolith.
    - Otolith processing and decoding described above provides a means to determine the contribution of supplementation programs to natural spawning populations.
    - To date, only a cursory examination of contribution rates has been done. A full examination would include temporal and spatial distribution, contribution by brood year & gender and estimates of fry-to-adult (ocean) survival rates.
    - Dr. Steven Schroder (leader of the Ecological Investigations Unit) in the WDFW Science Division will assist with this review.

5. Review of and coordination with habitat restoration and supplementation recovery strategies presented in relevant documents and processes, including:
    - the LCFRB's Recovery Plan (2004),
    - NOAA Fisheries (2006, 2007, 2008, 2009) guidance documents,

- NOAA Fisheries (2008) FCRPS Biological Opinion – Comprehensive Analysis and RPAs; and
- Coordination with other relevant salmon recovery and management entities –
    i. ODFW chum recovery planning and processes (Appendix 8),
    ii. LCFRB habitat restoration planning and activities,
    iii. LCREP habitat restoration planning and activities,
    iv. WDFW-BPA-Corps Estuary MOA implementation, and
    v. The expert panel for evaluation of the benefits of estuary habitat restoration projects established under RPA 35 (Appendix 9).

ISRP Request #4. Present a schedule of activities. The timelines for completion of Objectives 2 and 3 by February 2010 appear optimistic.

During initial coordination with BPA and proposal development during October-November 2008, a projected start date of March 2009 was selected for this project. In turn, this led to a projected completion date, one year later, of February 2010 for deliverables described in the proposal and ISRP narrative. These dates have proven to be overly optimistic and a revised timeline for the project has been developed. Project activities for months 1-12 of Performance Year 1 and 2 are described in Figures 7 and 8, respectively. A revised projected start date of August 1, 2009 is currently proposed. Figure 1 (Page 12 of this document) provides a schematic description of the sequencing of Year 1 activities that lead to the development of an Integrated Strategy for Chum enhancement in the lower Columbia River..

Project Performance Year 1

In the first year of the project, proposed activities fall within four main categories: Habitat restoration, Stock Status Assessment, Supplementation, and Population Monitoring & Evaluation (Figure 7).

Habitat Restoration

Primary activities and deliverables proposed for this category are:

1) Prioritized list of potential habitat restoration projects and chum spawning channel sites in Washington LCR tributaries describing the benefits of each.
2) Non-native vegetation (reed canary grass and Himalayan blackberry) removal from Hamilton Spring Channel.

Chum Project Activities Timeline – Project Performance Year 1

Month Number of Contract Period – with Contract Start Date at Month-0

Contract Start=0	1	2	3	4	5	6	7	8	9	10	11	12
TASKS:	Habitat Restoration											
Chum Habitat Projects	Develop Criteria		List of Potential Projects		Rank Projects		Select 1-3 Projects	Develop Adaptive Mgt Hypotheses				
Hamilton Spgs. Veg. Removal	Obtain permit map existing veg / remove											
	Stock Status Assessment											
DNA – Otolith Analyses	Processing (WDFW Lab)		Analysis (Dr. Small)		Report & Technology Transfer							
Stock Status Review						Population Abundance Estimates + Stock Status Updates (Rawding / Ryding)				SaSI Update		
Review Existing Supplementation Projects			Compile & Review Grays River and Duncan Creek Supplementation Data – Adult Returns vs. Previous Releases				Develop Adaptive Mgt Hypotheses					
	Supplementation Strategy											
Grays River Supplementation	Complete Council's (combined) Three-Step Review for Gray's River – Continue in Fall 2009		Collect Adult Broodstock			Juvenile Rearing and Release						
Future Supplementation Strategy						Develop an Integrated Supplementation/Reintroduction Strategy for New and Ongoing Habitat Restoration and Chum Enhancement Projects (will be submitted to ISRP for review upon completion)						
	Co-Management Coordination and Alignment with BiOp and Recovery Plans											
Recovery Strategies - Integration	LCR Chum ESA Recovery Plan & FCRPS BiOp RPA Review											
	Population Monitoring & Evaluation											
Population Status RM&E						Develop or Revise Study Design and Statistical methodology for Population Status and Habitat Effectiveness Monitoring						
Overall RM&E Plan	Incorporate all data analyses, habitat restoration evaluations, stock origin, genetic analyses, population estimates, supplementation program strategies, and ESA reviews into a comprehensive RM&E Plan – based on population status and trend, and habitat restoration effectiveness monitoring – for full implementation in Year 2 (will be submitted to ISRP for review upon completion)											
Assume Start 8-1-09	Aug 2009	Sep	Oct	Nov	Dec	Jan 2010	Feb	Mar	Apr	May	Jun	Jul

Figure 7. Linkage chart of stock assessment and habitat restoration tasks flowing into a comprehensive Supplementation Strategy and RM&E Plan for chum salmon restoration.

To develop a prioritized list of potential habitat restoration projects and chum salmon spawning channel sites, we propose to, first, finalize the criteria and process that will be used to evaluate projects. Our model for criteria development and project ranking is described in our response to ISRP Specific Comment #12 on page 86 of this document. Secondly, we propose to compile a comprehensive list of potential projects with direct benefit to chum salmon through a thorough review of existing habitat assessments, restoration project lists and newly proposed projects from 1) LCFRB (e.g. subbasin workgroups, watershed assessments, SRFB proposal process), 2) LCREP, 3) the BPA Estuary MOA, 4) WDFW, and 5) other salmon and habitat enhancement groups.

As stated in our initial proposal our intent "is not to conduct or re-evaluate habitat assessments already completed or compiled through the LCFRB or other processes, but instead to utilize the LCFRB Recovery Plan, existing stream habitat assessments and restoration project lists to develop a prioritized list of habitat restoration projects and/or locations within the LCR that would be the most beneficial to chum salmon." By month 5 of the project, we propose to begin evaluation and prioritization of the project list describing the potential benefits of each, so by month 7 we can select the 1-3 highest priority projects for initial scoping, preliminary budget development and integration into our reintroduction/supplementation strategy.

Removal of non-native vegetation from wetted areas of Hamilton Spring Channel would need to occur within the established in-water work window for this area of August 1st-31st. Work outside wetted areas of the channel (in some years the channel is completely dry) can likely be permitted outside of this work window. Assuming the timeline presented in Figure 7 begins August 1, 2009 this task would need to begin immediately if work is to be completed in 2009. A discussion of the merits of this proposed activity can be found in our response to ISRP Specific Comment #19 on page 96 of this document. In preparation for the potential completion of this task in August and September 2009, we have initiated the permitting process with WDFW's Habitat Division to ensure a Hydraulic Permit Application (HPA) and associated state and county permits can be secured in time. If this task is deferred or eliminated, the permit application(s) can be withdrawn.

Stock Status Assessment

Primary activities and deliverables proposed for this category are:

3. Processing and analysis of DNA and otolith samples.
4. Updated genetic analysis of LCR chum salmon population structure.
5. Update of WDFW's Salmonid Stock Inventory database (SaSI) with current population structure and updated abundance data.
6. Review of existing supplementation projects.

The DNA and otolith samples listed in Table 15 of this document have been collected and are currently archived. Processing of these samples would begin immediately upon project implementation with completion within the first three months of the project. Analysis of genetic samples and an initial summary report are proposed for completion by Dr. Maureen Small of the WDFW Molecular Genetics Laboratory by month 7 of the project. This analysis will update previous work on LCR chum salmon population structure (Small et al. 2004 and 2006) and results will be integrated into the development of our reintroduction/supplementation strategy.

A review of historical chum stream survey data, and development of standardized population abundance estimates are proposed for months 6-10 of the project. Combined with updated population structure information from the genetic analysis, this information will be used to update WDFW's Salmonid Stock Inventory (SaSI) database. A review of current supplementation programs on the Grays River and Duncan Creek, incorporating complete decoded otolith data, is proposed for months 2- 7 of the project, and will help direct adaptive management of these projects. Results of these reviews will be key elements in directing our reintroduction/supplementation strategy and in finalizing an RM &E plan.

Supplementation

Primary activities and deliverables proposed for this category are:

1) An NPCC Three-Step review for the Grays River Supplementation Program.
2) Up to 200,000 chum fry released from the Grays River Hatchery, thermally marked for identification upon recovery via otoliths from adult carcasses.
3) Development of a reintroduction/supplementation strategy for LCR chum salmon to link with habitat restoration and chum channel project implementation, including:
    a. Identification of priority populations for reintroduction/supplementation.
    b. Identification of reintroduction/supplementation method(s) suitable for priority populations.
    c. Identification of genetic stock source for reintroduction/supplementation of priority populations.

We propose to continue the Grays River chum supplementation program (currently unfunded) in 2009/10 by, first, conducting an NPCC Three-step Review for the program. For brand new hatchery programs or hatchery facilities, this process can be quite lengthy; however, for existing programs and facilities it is possible to conduct a "combined" Three-step review. Authors of this proposal successfully completed a combined Three-step review for the Duncan Creek chum supplementation program (Washougal Hatchery) in 2003. We propose to follow a similar format to the Duncan Creek review for the existing Grays River program, and have initiated discussions with Mark Fritch (NPCC F&W Program Implementation Coordinator) to begin the combined Three-step process. Completion of this review is proposed to occur within the first three months of the project, to allow broodstock collection in November 2009. Current program size is targeted at up to a 200,000 fed-fry release in the spring of 2010; however a review of the existing program and the Three-step review process will be used to develop adaptive management strategies for the program.

In month 6 of the project, after completion of the genetic analysis to update population structure and identify potential donor stocks, we propose to begin finalizing a reintroduction/supplementation strategy for LCR chum. As population abundance data updates, existing supplementation program review, and habitat project list development and selection are completed, these elements will be integrated into the strategy. A final strategy is proposed for completion at the end of performance year 1, and will be made available to BPA and the ISRP for review before implementation in performance year 2.

Population Monitoring and Evaluation

Primary activities and deliverables proposed for this category are:

1) Development of an M&E program for LCR chum populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/reintroduction programs and habitat restoration actions.
2) Development of associated budget.

Development of a comprehensive M&E plan integrating the LCFRB (2004) monitoring framework and priorities identified in the FCRPS BiOp will occur throughout performance year 1. After month 7 of the project, results from habitat restoration, stock status assessment, and supplementation strategy development (described above) will be integrated into the final M&E plan. Our response to ISRP request #3 elaborates on the conceptual design of the M&E plan proposed for completion at the end of performance year 1, which will be made available to BPA and the ISRP for review before implementation in performance year 2.

Project Performance Year 2:

For Year 2 of the project, proposed activities continue work within three categories: Habitat restoration, Supplementation, and Population Monitoring & Evaluation (Figure 8).

Habitat Restoration

Primary activity proposed for this category:

1) Initiate design, permitting, and/or construction of the 1-3 priority habitat restoration/chum channel projects identified in Year 1.

Depending on the scope, and projected cost of priority habitat projects identified in Year 1, one to three projects will be selected for implementation in Year 2. Work in Year 2 will consist of, design and engineering, final cost projections, permitting, and possibly construction. Construction in Year 2 will depend on the scope and size of the project, permitting, and alignment with in-water work windows.

Supplementation

Primary activities proposed for this category are:

1) Continuation of Grays River supplementation program.
2) Restore the Duncan Creek supplementation program.
3) An NPCC Three-Step review for the newly identified supplementation program(s).

In Year 2, the Grays River supplementation program is proposed to continue with broodstock collection in November-December 2010, and juvenile releases in spring of 2011. Program size, and rearing strategies will be dependent on the Year 1 review of the existing program and the NPCC Three-Step review process.

We also propose to restore the supplementation program for Duncan Creek, which was originally a component of the BPA funded (and ISRP reviewed) project - Reintroduction of Chum Salmon into Duncan Creek (#200105300). Broodstock collection for this program is proposed from November – December 2010. Egg incubation and initial rearing, and marking occurs at the Washougal Hatchery and fish will be released in April/May 2011.

Reintroduction and/or supplementation programs identified in Year 1 strategy development, corresponding to priority habitat projects, are proposed for implementation beginning in Year 2. The first step of implementation will be completion of a NPCC Three-Step review of these projects.

Month Number of Contract Period – with Contract Start Date at Month-0		
Contract Start=0	1 2 3 4 5 6 7 8 9 10 11 12	
TASKS:	**Habitat Restoration**	
Chum Habitat Projects	Initiate design, permitting, and/or construction of the 1-3 priority habitat restoration/chum channel projects identified in Year 1.	
	Supplementation Strategy	
Grays River Supplementation	Collect Adult Broodstock	Juvenile Rearing and Release
Duncan Creek Supplementation*	Collect Adult Broodstock	Juvenile Rearing (Washougal Hatch.) and Release (Duncan Ck.)
New Supplementation Program(s)	Conduct Council's Three-Step review, develop HGMP (if artificial production is to be utilized), and begin planning for new supplementation/reintroduction program (s) identified in Year 1 (Supplementation Strategy) – in alignment with habitat restoration/chum channel projects.	
	Implementation of Population Monitoring & Evaluation Plan	
Adult Chum M&E – Incorporate and align existing BPA projects.	BPA projects – "Below the Dams" (#199900301) and Reintro. of chum in Duncan Ck. (#200105300)	
-Implement other status and trend & effectiveness monitoring.	Implement in Grays River and other areas as outlined in M&E plan (Year 1).	
Juvenile Chum M&E – Incorporate and align existing projects.		**BPA project:** Reintro. of chum in Duncan Ck. (#200105300). **NOAA BiOp funding:** Grays River juvenile trap
Implement other status and trend & effectiveness monitoring.		Implement in Hardy & Hamilton Creeks and other areas as outlined in M&E plan (Year 1).
Assume Start 8-1-10	Aug 2010, Sep, Oct, Nov, Dec, Jan 2011, Feb, Mar, Apr, May, Jun, Jul	

Figure 8. Chum salmon enhancement project activities timeline – Project Performance Year 2.

Population Monitoring and Evaluation

Primary activity proposed for this category:

1) Implementation of Population Monitoring and Evaluation Program developed in Year 1.

Two BPA funded (and ISRP reviewed) projects currently conduct adult and juvenile chum monitoring – Evaluate Spawning of Fall Chinook and Chum Salmon Just Below the Four Lowermost Mainstem Dams ("Below the Dams) (#199900301) and Reintroduction of Lower Columbia River Chum Salmon into Duncan Creek (#200105300). Additionally, a project on the Grays River (funded through 2009, primarily via NOAA BiOp funds) conducts juvenile monitoring for chum salmon. In Performance Year 2, proposed implementation of the M&E plan developed and reviewed in Year 1 will consist of integrating these existing adult and juvenile monitoring projects with newly developed monitoring activities. Monitoring of adult spawner abundance will occur in the fall of 2010, with subsequent juvenile monitoring in spring 2011.

ISRP Request #5. Clearly define the specific benefits of the combination of habitat restoration for wild fish and supplementation, including a description of how these elements operate in a mutually beneficial way to restore the chum salmon run.

Historically, hatchery fish have had little influence on the wild component of the CR chum salmon ESU (NMFS 2000 FCRPS BiOp Appendix C). The HSRG (2008) concluded that the use of chum conservation hatchery programs should be viewed as an important short-term risk management strategy to preserve the genetic legacy of depressed chum salmon in the Columbia River. It supported this conclusion with the following points:

- Hatchery intervention can reduce demographic risk by boosting abundance;
- Additional conservation propagation programs should be promptly initiated within each of the ESU's three geographic strata to reduce this risk;
- These programs should last up to three generations;
- Broodstock should be selected from the target population, or in the case of reintroductions, from the most suitable available population; and
- The need for hatchery intervention has been also recognized by others and funding appears to be available to pursue chum hatchery programs following more detailed planning.

Chum salmon hatchery programs have been associated with increased abundance of natural chum populations, most notably summer chum salmon in Puget Sound. Hatchery chum salmon populations are less likely to be affected by domestication given their short-term culture. Recently, there have been two hatchery conservation programs for chum salmon in the Columbia Basin, Grays River/Chinook River (WA) in the Coast stratum (1998-2008), and Duncan Creek (WA) in the Gorge stratum (2001-2007), both are currently unfunded. The HSRG recommends the continuation of the current chum conservation programs in Grays River and Duncan Creek.

Small et al. (2009 unpublished manuscript) discuss the reduced domestication benefits supplementation programs relative to other potential issues such as genetic diversity and effective population size:

> *"Incorporating more spawners adapted to natural conditions into hatchery brood stocks is hypothesized to lessen overall domestication selection in the population in comparison to using hatchery-origin brood stock (Lynch and O'Hely 2001; Ford 2002; Araki et al. 2007). However, hatchery programs may still pose risks to genetic diversity and effective population size (N_e) if hatchery fish arise from small brood stocks and numerically overwhelm wild-origin fish on natural spawning grounds. This may increase overall variance in family sizes in the total population (Ryman-Laikre effects, Ryman and Laikre (1991), and decrease genetic diversity and N_e, the key parameters determining the adaptive potential of a population (Hedrick 2005)."*

WDFW will monitor the genetic attributes discussed above – as part of the stock assessment M&E component.

The HSRG (2008) further recommends that fishery managers implement the following actions to protect wild populations, while implementing the supplementation strategies:

1. Promptly plan, develop and implement at least one additional chum salmon reintroduction or conservation program in both the Coast and Gorge strata and at least two programs in the Cascade stratum.
2. Programs should include a sunset clause that would suspend the hatchery program after three generations, unless evidence suggests suspending releases earlier or extending the program beyond three generations would benefit the populations.
3. All hatchery-origin fish should be marked and the proportion of hatchery fish on the spawning grounds monitored.
4. Investigate ecological variables that might be constraining the viability of the chum salmon in the Columbia River and develop one or more plausible hypothesis.
5. Based on results of the initial propagation programs and the plausible hypotheses about the cause of decline, consider additional reintroduction programs to achieve, at a minimum, preservation of the genetic identity and reduction of demographic extinction risks.

NOAA Fisheries (2007) summarized Action Agency-funded hatchery programs that are the subject of ESA Program-level Consultation, including the Duncan Creek Chum programs (Table 13). The overall benefit of chum supplementation is to prevent extinction and preserving genetic resources of distinct populations in the LCR. VSP parameters positively affected by these supplementation programs are:

- Abundance (A)
- Spatial Structure (SS)
- Diversity (D).

Table 13. Past and future benefits summary – including VSP parameters positively affected – for the Duncan Creek chum supplementation program and future federally funded pilot supplementation programs for chum salmon in selected Lower Columbia River tributaries (NOAA Fisheries 2007).

PAST ACTIONS (2000 - 2006) Benefits Summary

Population	Action Agency Hatchery Action		VSP Parameters Positively Affected				Benefit accrued to natural population during (D) or after (A) BiOp period	Comments
			A	P	SS	D		
Lower Columbia Gorge Tributaries	BPA funded the program to re-introduce Columbia River chum salmon in Duncan Creek		X		X	X	H benefit for preventing extinction and preserving genetic resources of the population. (BPA)	No action in the Coarse Screen for this ongoing program.

FUTURE ACTIONS Benefits Summary

Population	Action Agency Proposed Hatchery Action	Continuation of Ongoing Action or New Action	VSP Parameters Positively Affected				Benefit accrued to natural population during (D) or after (A) BiOp period	Comments
			A	P	SS	D		
Lower Columbia Gorge Tributaries	Fund the program to re-introduce Columbia River chum salmon in Duncan Creek as long as NOAA Fisheries considers it beneficial to recovery and necessary to reduce extinction risk of the target population.	Continued	X		X	X	H benefit for preventing extinction and preserving genetic resources of the population **during** and **after** the period of the BiOp. (BPA)	No action in the Coarse Screen for this ongoing program.
ESU-wide	Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River Tributaries below Bonneville Dam.	New	X		X	X	H benefit for preventing extinction and preserving genetic resources of the populations **during** and **after** the period of the BiOp. (BPA)	No action in the Coarse Screen for this new proposal.

WDFW generally agrees with Oregon's (2009) chum recovery strategy – that is based on HSRG recommendations regarding conservation hatchery supplementation, and further recognizes that successful recovery of chum salmon is highly unlikely unless the factors for their decline are addressed concurrently, and as an integrated component of hatchery supplementation. As such, the artificial propagation component of the chum salmon recovery strategy is viewed as a relatively short-term measure (3 generations) aimed at ensuring the development of sustainable wild populations, while key limiting factors (*i.e.* Habitat, Harvest, Hydro) continue to be addressed over a much longer time period.

ISRP Request #6. Describe the adaptive management experiment. The proposal indicates planning for adaptive management of the existing chum salmon supplementation program. Adaptive management sensu Walters, Hilborn et al. is an experiment. A description should be added of how planning for adaptive management of such a program is to be conducted; e.g., what sorts of adaptive management experiments could be designed, what hypotheses would be tested, and what the experiments would have to take into account.

Definitions of "Adaptive Management" (refer to Appendix 1.2)

The functional definition of the "Adaptive Management" concept varies according to the application and the complexity of the relevant Hatchery, Harvest, Hydro or Habitat management action under consideration. For example, adaptive management of a specific tributary fishery may involve tools such as creel surveys and time-area-gear restrictions to make in-season adjustments in order to achieve a limitation on take of a listed species; whereas adaptive management of Washington PFMC ocean and inside fisheries has evolved into a complex "North of Falcon" process that incorporates biological, economic, institutional, social, cultural, and inter-national considerations within a well-defined Federal-State-Tribal organizational structure.

Similarly, adaptive management of planning processes such as the Council's Fish & Wildlife Program, Subbasin Plans for a watershed or region, a NMFS-approved ESA Species Recovery Plan, or a specific enhancement project that implements a component of a recovery plan – would all vary in complexity. However in the latter example, it has been recognized by the Columbia Basin Fish & Wildlife scientific community and agency administrators – that a common or compatible framework is needed for Basin-wide programs, ESU-level plans or focused enhancement projects.

NPCC (1984) simply defined Adaptive Management as – *learning by doing*. Others have proposed to incorporate the scientific method into Adaptive Management by designing a large-scale field experiment (e.g., a habitat enhancement project) to test specific hypotheses.

According to the LCFRB (2004), the term "adaptive management" is in wide usage among subbasin planners and has come to denote two very different processes (see Appendix 1.2.1 for more details):

- *"A broad definition involves course correction during plan implementation based on observed progress and refinements in approach or objectives.*

- *An alternative definition involves a specific approach whereby substantive actions are implemented in order to invoke a significant response that provides clear direction for tuning*."

The following definition is relevant to ESA Recovery Plans (NMFS 2007):

> *"Adaptive management is the process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends are proposed, prioritized, and implemented when necessary."*

Adaptive Management Framework for Project 2008-710-00

In the Chum Enhancement Project proposal, WDFW uses the term Adaptive Management within the ESA Recovery Framework detailed by NMFS (2007) ; refer to Appendix 1.2.2 for more detail. The NMFS (2007) guidance document provides relevant information in the following sections:

- Section 3 provides a conceptual overview of adaptive management.
- Section 4 describes guiding principles for the development of two types of monitoring: *status and trends monitoring* and *effectiveness monitoring*.
- Section 5 discusses, at a conceptual level, the issues related to prioritizing monitoring in the face of resource constraints.
- Section 6 illustrates how monitoring program design can affect the level of certainty that can be attained in evaluating ESU status.

Excerpt on Adaptive Management (NMFS 2007; Appendix 1.2.2):

Adaptive management is the process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation, and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends are proposed, prioritized, and implemented when necessary.

An adaptive management plan must include the following elements (Anderson 2003):

- Management strategies that are revisited regularly;
- The use of conceptual or quantitative models of the system being managed to develop and test hypotheses and to guide strategy and action planning;
- A range of potential management actions that could be used to meet the strategy;
- Monitoring and evaluation to track progress;
- Mechanisms for incorporating learning from monitoring and evaluation into decisions on actions and strategies; and
- A collaborative structure for stakeholder participation in adjusting management strategies and actions.

Adaptive management is crucial for salmonid recovery programs because of the length and complexity of the salmonid life cycle and the uncertainties involved in improving salmonid survival and status. The key is to build explicit links between management actions, monitoring data, and biological and physical responses. Several types of monitoring are needed to support adaptive management:

- Implementation and compliance monitoring, used to evaluate whether the recovery plan is being implemented.
- Status and trend monitoring, which assesses changes in the status of an ESU and its component populations, and changes in status or significance of the threats to the ESU.
- Effectiveness monitoring, which tests hypotheses on cause-and-effect relationships and determines (via research) if an action is effective and should be continued.

It is also important to explicitly address the many unknowns in salmon recovery – the “critical uncertainties” that make management decisions much harder. Critical uncertainty research may seem expensive or unnecessary in light of basic information needs; however, in the long run, it will reduce monitoring and implementation costs.

As local recovery planners begin to design monitoring programs for salmon recovery, they will need to address the issues that are discussed conceptually throughout this document, including:

1) Clarifying the questions that need to be answered for management decision making.
2) Identifying which populations and associated limiting factors to monitor.
3) Addressing questions of metrics and indicators – frequency, distribution, and intensity of monitoring – and the tradeoffs and consequences of these choices.
4) Assessing the degree to which existing monitoring programs are consistent with this guidance document and identifying needed adjustments in those programs as well as additional monitoring needs and a strategy for filling them.
5) Developing a data management plan (see Appendix B of NMFS 2009).
6) Prioritizing research needs to address critical uncertainties, test assumptions, and provide other information to support decision making.

How the Scientific Method and Hypothesis Testing Fit into Adaptive Management, Monitoring and Evaluation

The LCFRB (2004) Salmon Recovery Plan made the following observation on testing hypotheses on the salmon enhancement project level:

> *"Working hypotheses provide a sound basis for identifying and scaling a suite of appropriate recovery actions but substantial refinements in the scope and focus of measures will be needed as the recovery effort unfolds. Some measures may not produce the desired effects. Other measures will exceed expectations. Unexpected events will occur. A robust and adaptive monitoring, research, and evaluation framework will be critical for weighing progress toward recovery and making appropriate course adjustments along the way."*

The Chum Enhancement Project could be viewed as a grand adaptive management experiment with overarching hypotheses to be tested; however, that would accomplish little more than a restatement of the purpose and goals of the project. Examples of such hypotheses would be:

- Supplementation of artificially propagated chum fed-fry – derived from natural-origin parents – into functioning rearing habitats currently not inhabited by chum salmon will (will not) produce a viable self-sustaining chum population over a 15-year time period.
- Restoration of degraded habitat that previously supported a viable chum salmon population but is now devoid of chum, combined with supplementation of artificially propagated chum fed-fry into this rehabilitated habitat will (will not) produce a viable self-sustaining chum population over a 15-year time period.
- Supplementation of natural-origin adult chum spawners into a engineered chum spawning channel adjacent to functioning rearing habitats currently not inhabited by chum salmon will (will not) produce a viable self-sustaining chum population over a 15-year time period.

We prefer to utilize the NMFS (2007) framework that incorporates status and trend monitoring to evaluate the efficacy on the chum supplementation management actions at each site. Status and trend monitoring – with statistically valid methodology will determine if a supplemented chum population – in a functioning or rehabilitated habitat – is increasing or decreasing in abundance. It cannot alone determine if there is a cause-effect relationship between supplementation and population change. Likewise, monitoring of an adult spawning population can determine if the numbers (proportions) of supplementation-origin versus natural-origin chum salmon changes over time.

Two aspects of the Adaptive Management-M&E Plan will incorporate hypothesis testing:

1) The effectiveness monitoring of habitat restoration actions, and
2) critical uncertainties research to gain knowledge of key biological relationships comprising the scientific foundation for the supplementation program.

NMFS (2007) states the importance of incorporating effectiveness monitoring into the Adaptive Management – M&E Plan:

> *While status and trends monitoring can produce data on population status and on the status of the potentially limiting factors, without some modeling (quantitative, qualitative, heuristic), supported by effectiveness monitoring data, it is impossible to translate between these two data sets or types, i.e. to make cause-and-effect statements. It is essential to build effectiveness monitoring into the implementation plan at the outset, because it requires explicitly coupling the monitoring design and implementation with the action design and implementation in order to detect an effect. Recovery plan implementation should consist of action strategies that include the demonstration of effect.*

NMFS (2007) also describes the role of critical uncertainties in recovery planning – the current suite of unanswered questions – can also drive monitoring:

> *There is real and necessary value to data collection programs that address the critical uncertainties confounding our ability to make effective management decisions. This research-based monitoring is also driven by management questions, in a less direct, but equally important, manner.*

This NMFS guidance document presents some basic design principles to help develop efficient and effective monitoring programs.

ISRP Request #7(a). Provide a clearer description of what is the reintroduction aspect versus the supplementation aspect of the proposal. Except where needed to rescue a severely diminished local chum population (and where harvest control and/or rapid habitat restoration could not accomplish that), there does not seem to be adequate justification presented for the proposal's "supplementation" component, that is, the artificial propagation that constitutes true supplementation. The proposal's artificial propagation components that are for **reintroduction** ***may be justified, however.***

We will address the reintroduction versus supplementation question – but first the following points should be clearly understood:

(1) Chum salmon are functionally extirpated from nearly all Oregon LCR tributaries (ODFW 2009); furthermore, nearly all Washington-side local chum salmon populations are severely diminished. Therefore, the qualifier "*Except where needed to rescue a severely diminished…*" in the ISRP statement above is out of context. Nearly all local populations of chum salmon in the LCR are currently at such depleted levels that supplementation would be beneficial; the real question is where to start.

(2) The statement "*where harvest control … could not accomplish that*" shows a lack of understanding – since harvest is currently not significantly impacting the extant LCR chum populations in Washington {WDFW-FMEP (2009); NOAA Fisheries FCRPS Biological Opinion (NMFS 2008, Section 8.9)}. Refer to WDFW Specific Response #1 for details.

(3) The statement "*where … rapid habitat restoration could not accomplish that*" also indicates a misunderstanding of this proposal – since viable chum populations do not exist in most tributary areas where habitat restoration is needed or ongoing; i.e., target habitat is currently degraded and unseeded or recently restored and unseeded. We are proposing concurrent chum reintroduction and high-impact habitat restoration as our primary strategy.

We use the term **reintroduction** in the context of a Recovery Goal for LCR chum in habitats that they have been functionally extirpated. We define **supplementation** as an implementation strategy to achieve the goals of reintroduction and recovery. **Artificial production** is a tool that can be used in various ways to implement a supplementation strategy. WDFW plans to incorporate at least five alternative methods to implement supplementation strategies in conjunction with habitat restoration:

(1) Transport and release live adult chum salmon spawners into the selected spawning habitat;

(2) Fertilize eggs in a hatchery and put into RSIs in selected habitats – for subsequent *in-situ* incubation, hatching, and volitional release;

(3) Fertilize eggs in a hatchery and upon hatching release fry into the selected rearing habitat;

(4) Fertilize eggs in a hatchery and upon hatching feed the fry to a specific size before releasing into the selected rearing habitat; and

(5) Natural recolonization by adult spawners into restored spawning habitat or constructed spawning channels.

Refer to the decision tree below (Figure 9) – with respect to how supplementation strategies would be implemented.

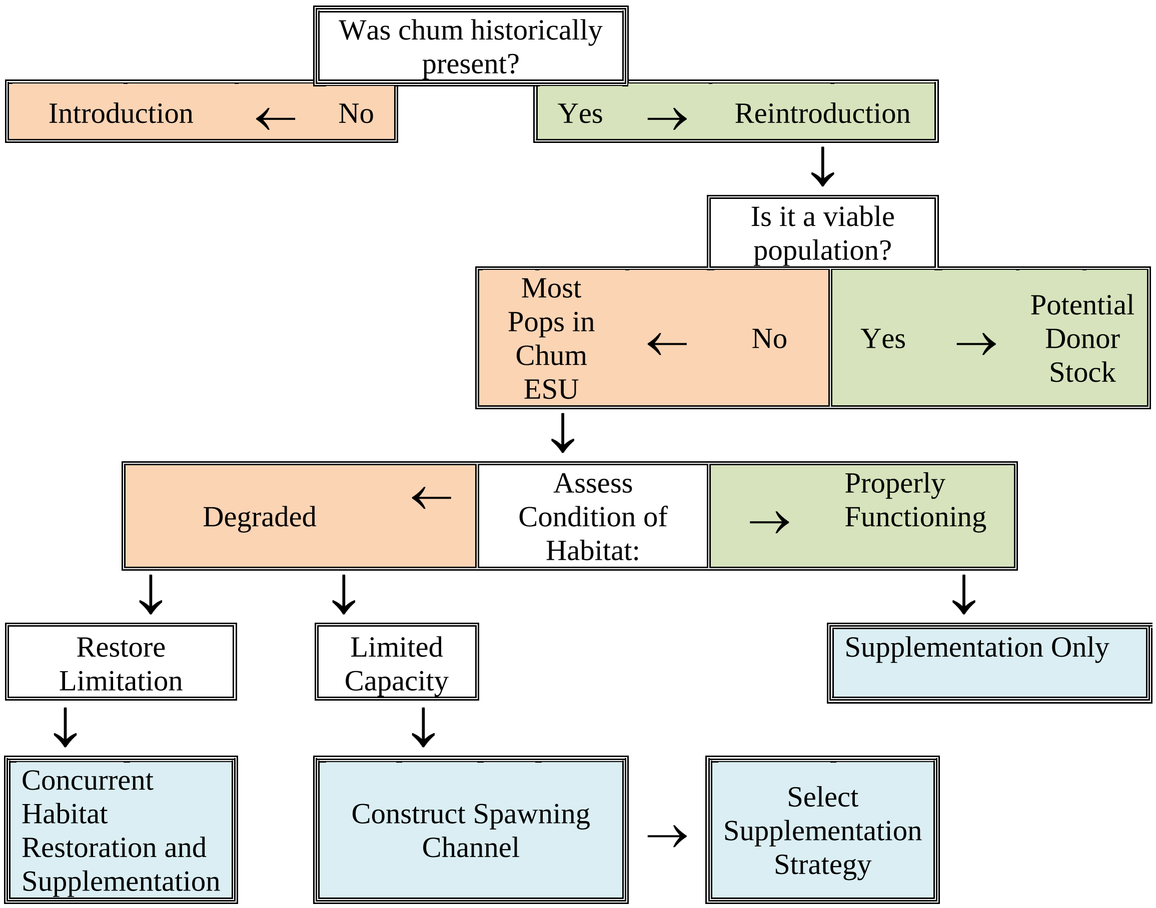


Figure 9. Decision tree for implementing LCR chum salmon supplementation strategies.

The LCFRB Recovery Plan (2004) supports supplementation as a rebuilding strategy:

- *"using hatchery supplementation to rebuild depressed natural runs as a temporary measure until habitat or passage improvements are completed…"*
- *"In some cases, hatchery influences are minimal and wild fish may be used in a hatchery to jump start natural populations through supplementation in some areas where habitat restoration has been effective (e.g. Grays River and Duncan Creek chum)."*

We will further delineate reintroduction and supplementation under Objective 3 of our proposal: Develop a supplementation/reintroduction strategy for Lower Columbia River chum salmon. These terms have been defined for summer chum under the Summer Chum Salmon Conservation Initiative (SCSCI) - An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca Region (2000) and this plan will likely be used to guide our development of the decision making process on supplementation /reintroduction.

Deciding when to reintroduce or supplement a summer chum population requires careful consideration of the need and consequences of such an action. Supplementation should only be done to rebuild a population when that population is at risk of extinction, or to develop a brood stock for reintroduction (page 108 of SCSCI 2000).

Using this practical definition and looking at recent escapement levels for Lower Columbia River chum salmon (Table 14), it can be argued that all populations, except the Grays population, would be candidates for supplementation based on extinction risk. Also, at these low population levels it is unlikely that just habitat restoration would be sufficient to stop/reverse the decline. At this stage of the project, we are only proposing to continue two supplementation programs, Grays River and at Duncan Creek. Duncan Creek was initially a combination of supplementation (via fed-fry) and reintroduction (direct adult plants) but budget cuts in F0FY 08 have reduced it to only reintroduction and M&E. The Grays River program would continue under this project as a source of broodstock/fed-fry for reintroduction programs in both Washington and Oregon and to supplement the Grays River population.

A fully developed and reviewed supplementation/ reintroduction plan for Lower Columbia River chum salmon will be produced under this project. However, it is likely we will follow the lead of the SCSCI (2000) and the objectives in developing our supplementation/reintroduction projects will be to:

1) rebuild chum populations at risk of extinction,
2) restore chum to streams where a viable spawning population no longer exists,
3) maintain or increase chum populations of selected streams to a level that will allow their use as broodstock donors for streams where chum population have been lost, and
4) avoid and reduce the risk of deleterious genetic and ecological effects.

Measuring and documenting hatchery/wild impacts will be addressed under the Population and Evaluation Plan (Objective 4) of our proposal. All program-origin fry will be marked allowing identification when recovered as carcasses in commercial fisheries, on spawning ground surveys or at hatchery racks, via otolith analysis. Guidelines relating to hatchery origin adults interacting with native spawners recently released by the Hatchery Scientific Review Group for chum salmon will likely be incorporated into our plan. Preliminary data on the proportion of hatchery-origin spawners recovered during spawning ground surveys, Grays River basin are presented in Table 15.

Table 14. Chum salmon abundance estimates for Southwest Washington and LCR Tributaries, 2002-2007 (source: Todd Hillson and Julie Henning, WDFW).

River or Tributary	2002	2003	2004	2005	2006	2007
Grays River	11,713	16,667	14,367	4,195	6,115	3,832
Skamokawa Creek	159	152	31	24	153	55
Elochoman River	13	26	3	11	306	4
Mill Creek	0	0	0	0	---	---
Abernathy Creek	33	40	0	0	---	---
Germany Creek	38	76	6	2	1	2
Cowlitz River	---	15	8	13	8	5
Coweeman River	---	---	0	---	---	---
Kalama River	---	2	1	---	---	---
Lewis River	28	86	15	8	5	31
EF Lewis River	3	2	3	3	0	
Hatchery outlet Creek	30	1	0	6	3	0
Josephs Creek	12	10	0	0	5	1
Mainstem- I 205	3,468	2,844	2,102	1,009	862	544
Washougal	24	7	0	0	0	---
Lacamas Creek	21	28	25	0	0	1
Mainstem- St Cloud	---	167	104	92	173	9
Mainstem- Multnomah	1,267	1,130	665	211	313	115
Mainstem- Horsetail	---	---	106	40	63	17
Mainstem- Ives	4,232	667	336	229	348	145
Duncan Creek	13	13	2	7	42	9
Woodard Creek	0	0	0	0	0	0
Hardy Creek	343	392	49	73	104	14
Hamilton Creek	1,794	863	568	258	482	123
Greenleaf Creek	106	0	1	---	---	

Note: Several population estimation methods were used to create the data in this table. Readers should use caution when comparing between years and locations especially for areas with low abundance since many are AUC, peak counts or counts from presence absence surveys without error/bias estimates.

There has been extensive work on hatchery and wild chum fry interactions/impacts in the Hood Canal. They found that chum fry occupy different areas and utilize different prey items at different sizes. Because of this, we expect little direct competition between naturally produced fry (start emigration at 35-40 mm) and hatchery origin fed-fry (start emigration at 55-60 mm) in streams. If unfed fry are released they may have a greater likelihood for interaction with native fry chum since they are of similar size, and likely use the same areas for foraging during migration.

The question was posed "*to what extent will enhanced chum (fry) merely become forage for enhanced coho, Chinook, steelhead, cutthroat trout, etc?*" There has been no chum specific predation research in the Lower Columbia River to answer this question. WDFW has taken steps though to reduce the likelihood of this occurring in streams where both hatchery chum and larger yearling sized hatchery smolts are produced. This has been done primarily through time of release, hatchery chum are released and given a reasonable time to clear the system before yearling smolts are released. Since chum fry typically immediately migrate, this practice should reduce/eliminate interactions in the streams. To what extent predation occurs on hatchery origin chum fry in the estuary and in near-shore areas is unknown but assumed to be small.

Table 15. Percent hatchery-origin spawners recovered during spawning ground surveys, Grays River basin.

Year	# Otoliths decoded	# Natural origin (no thermal mark)	# Hatchery origin (thermally marked)	% Hatchery origin	Spawner population estimate
2003	737	665	72	9.77%	16,667
2004	648	638	50	7.72%	14,364
2005	--	--	--	--	--
2006	906	826	80	8.80%	6,115

Otoliths from the 2005 spawning season have not been decoded due to lack of funding.

To date, little information is known about returns to Bonneville area spawning grounds of Duncan Creek project hatchery-origin adults. We are still waiting for complete decoding of otoliths recovered during the falls of 2007 and 2008. As a result, we only have one complete brood year return to look at, the last adults expected from the 2001 brood year returned fall of 2006. Twenty-three females were spawned in 2001 to produce 45,046 hatchery fed-fry that were released in spring of 2002, 67 adults were estimated to have returned from this release (all in 2005 as age-4 adults) resulting in a fry-to-adult survival rate of 0.15%.

Information on returns resulting from the adult supplementation at Duncan Creek is not available at this time. Strontium marking of fry produced in the channels was not initiated until 2004 due to permitting issues. The first year of adult returns from 2004 outmigrants would have been 2006, age-3 adults, and no strontium marked otoliths were recover that year. However the sample size was extremely small, only 14 of the 456 otoliths recovered came from age-3 adults. Similarly to what was detailed above, otoliths recovered in 2007 and 2008 have not yet been examined for the presence/absence of a strontium mark.

ISRP Request #7(b). The usual argument from managers in support of supplementation as a restoration strategy is that there is intact, under-seeded, spawning and juvenile rearing habitat; i.e., the life-stage with excessive mortality is in habitat outside of the freshwater spawning and rearing domain. The proposal implies that with chum salmon the limiting condition is spawning habitat. It is not clear how supplementation is intended to ameliorate this bottleneck.

The HSRG notes that 13 of 16 historical populations of Columbia River chum salmon are severely depressed even though Washington's Lower Columbia River Recovery Plan (LCFRB 2004) indicates habitat is available to support much larger populations. Under current habitat conditions, managers estimate an ESU abundance of 24,000 chum salmon can be supported. With habitat improvements to tributaries, an estimated ESU abundance of 115,000 chum salmon is possible (HSRG 2008a).

Summary of Current Spawning Areas

Currently, chum salmon spawning is concentrated in two main areas on the Columbia River: Grays River, a Columbia River tributary near the mouth; and mainstem Columbia River spawning areas between the I-205 Bridge and Bonneville Dam, including Washington shore tributaries (Duncan, Hamilton, and Hardy creeks).

Some chum salmon pass Bonneville Dam, but there are no known extant spawning populations in Bonneville pool. Chum salmon enter the Columbia River from October to December, and reach Grays River spawning areas in mid- October through early December. Fish returning to spawning areas above the I-205 Bridge and have a more protracted spawn timing (November to mid-January).

WDFW surveyed other potential chum spawning areas between the Grays River and I-205 Bridge from 2002-2007 and found only small numbers of chum salmon (Tabe 14).

Habitat Restoration Efforts and Concurrent Reintroduction

Anadromous salmonid habitat restoration has been ongoing in the Lower Columbia River at an increasing pace since the LCR salmon ESUs were listed:

- Lower Columbia River Estuary Partnership (LCREP);
- Lower Columbia Fish Recovery Board;
- Washington-BPA-Corps Estuary MOA for Habitat Restoration

We are not proposing to replace habitat improvements with supplementation /reintroduction actions nor do we believe that supplementation /reintroduction without improving habitat will lead to the recovery of LCR chum salmon. We do believe that the lack of high quality protected off-channel spawning/rearing habitat is a major limiting factor to chum salmon recovery in some locations. Our plan will combine habitat improvements when possible, spawning channels where habitat improvements are not possible or feasible, with supplementation / reintroduction programs to seed the restored habitat. We feel reintroduction using supplementation strategies will be necessary in most locations due to the extremely low population levels that currently exist in most historical chum spawning areas. Each of individual supplementation / reintroduction projects will need to go through the Councils Three-Step review process and have a HGMP prepared prior to implementation.

ISRP Comments by Proposal Section

In the 2007-09 review of 20071500 – Expand salmonid monitoring in Grays River to meet monitoring needs identified in the Lower Columbia Salmon Recovery and Subbasin Plan and maintain at risk chum salmon population through supplementation, the ISRP concluded that:

“What is missing … is any indication that the performance of the natural population can be improved based on the inherent performance of a hatchery stock. It is questionable that a supplementation program will accelerate effort to sustain wild production or maintain or improve conditions for wild fish. The supplementation portion of the proposal is not as important as the monitoring portion until a better understanding exists of stock status and trends. However, the issue of supplementation can be addressed more thoroughly during a Three-Step Review.”

ISRP Specific Comment #1: That conclusion remains applicable to this proposal. The lack of clarity in identifying any limiting factors suggests that it is not known why the chum stocks have declined. Also, the sponsor needs to consider potential hatchery/wild impacts. In addition, how do these recovery efforts consider inter-species issues? To what extent will enhanced chum (fry) merely become forage for enhanced coho, Chinook, steelhead, cutthroat trout, etc?

WDFW Response:

Regarding limiting factors for chum in the LCR – please refer to WDFW Response to ISRP Request #1 (page 18 above). The cumulative effects analysis of the NOAA Fisheries FCRPS Biological Opinion (NMFS 2008, Section 8.9) summarizes the key limiting factors for Columbia River Chum salmon (see Appendix 4 for details). Under current conditions, the three key limiting factors are:

1. Mainstem Hydropower impacts; especially on the Gorge populations;

2. Estuary habitat degradation is an important limiting factor for all chum populations – refer to NMFS (2006); and
3. Reduced tributary stream habitat function and wide-spread watershed degradation.

General agreement exists among state and federal scientists, that historical and current hatcheries practices have not been a significant limiting factor for chum salmon in the LCR. Relative to proposed hatchery supplementation, potential hatchery/wild impacts will be assessed via monitoring the distribution of uniquely-marked supplementation groups in various habitats, including spawning grounds.

Also refer to WDFW Response to ISRP Request #5

Inter-specific predation – by either resident fish or other species/life stages of salmonids – on chum juveniles is unknown and is a critical uncertainty (NMFS 2008). A large research effort would be needed to quantify the impact of predation by larger salmonid juveniles (coho, Chinook, steelhead, cutthroat trout) on chum fry in various habitats, i.e., tributaries, the mainstem migration corridor and the estuary.

1. **Technical Justification, Program Significance and Consistency, and Project Relationships (sections B-D)**

ISRP Specific Comment #2: This is a proposal to develop a plan for an integrated program of habitat restoration, supplementation/reintroduction, and monitoring and evaluation for Lower Columbia River chum salmon recovery. The technical justification is not sufficient for reviewers to determine whether the proposed new integrated plan is necessary. There is already an existing integrated plan (Lower Columbia Fish Recovery Board [LCFRB] Salmon Recovery Plan 2004). *It would be valuable to identify how this proposed planning process differs from, is similar to, or extends the efforts under the LCFRB Salmon Recovery Plan.*

WDFW Response:

The LCFRB Salmon Recovery Plan (2004) supports WDFW's approach for using chum supplementation as a rebuilding strategy:

- "*using hatchery supplementation to rebuild depressed natural runs as a temporary measure until habitat or passage improvements are completed…*"
- "*In some cases, hatchery influences are minimal and wild fish may be used in a hatchery to jump start natural populations through supplementation in some areas where habitat restoration has been effective (e.g. Grays River and Duncan Creek chum).*"

See our response to ISRP General Comment #3 (page 9 of this document) – regarding the need for an updated Integrated supplementation strategy – as proposed in this project.

The HSRG (2008) also supports a planning effort to implement new chum supplementation efforts in each Recovery stratum of the Columbia Chum ESU:

> "*Hatchery intervention can reduce demographic risk by boosting abundance. Additional conservation propagation programs should be promptly initiated within each of the ESU's three geographic strata to reduce this risk. Existing and candidate populations for hatchery conservation programs are identified in Table 4. Chum conservation programs can be rapidly implemented at existing facilities at modest cost. Programs should be sized at 100,000 to 200,000 fry releases. These programs should last up to three generations. Broodstock should be selected from the target population, or in the case of reintroductions, from the most suitable available population.*
>
> *The need for hatchery intervention has been recognized by others and funding appears to be available to pursue chum hatchery programs following more detailed planning. We recommend planning be immediately initiated leading to one or two programs for initial implementation in each stratum. The planning process should also include the development of a set of hypotheses regarding the likely causes of the decline of chum. Based on these hypotheses, the role and objectives of conservation hatcheries in a comprehensive recovery plan should be defined. Additional reintroduction or other conservation programs could then be considered based on monitoring and evaluation results. … In summary, the use of chum conservation programs should be viewed as an important short-term risk management strategy to preserve the genetic legacy of depressed chum populations.*"

ISRP Specific Comment #3: In a table, the sponsors list three BPA-funded projects and state that these "will be incorporated into population M&E plan developed in this proposal for implementation in FFY 2010." *The sponsors do not describe their actual plan for coordinating with other projects or time sequencing*.

WDFW Response:

See our response to General Comments #3 (page 9) and ISRP Request #4 (page 53 of this document).

ISRP Specific Comment #4 *It would be helpful for the authors to identify specific cases and locations in the Lower Columbia River where factors such as sediment, loss of habitat diversity, competition, predation, etc. have presented problems, and to give evidence that these are specifically identified problems in the Lower Columbia River rather than just general concerns.*

WDFW Response:

Regarding limiting factors for chum in the LCR – please refer to WDFW Response to ISRP Request #1 (beginning on page 18) – including summaries presented in Tables 3 and 4.

Fulton (1970) reported that chum salmon used 22 of 25 historical spawning areas in the lower Columbia River below The Dalles Dam. Even at the time of publication, access to suitable tributary habitat was limited by natural (falls, heavy rubble, and boulders) and manmade structures (dams and water diversions). Habitat quality was limited by siltation where watersheds had been subjected to heavy logging.

The Gorley Springs area was in fact lost in the winter of 1999 to an avulsion that destroyed the dyke protecting it. The BPA-funded Gorley Springs Project was in response to the flood damage, estensive bedload movement, and sedimentation that caused loss of chum habitat diversity.

Similarly, the Duncan Creek project was predicated on the removal of a culvert and earthen dam, and replacement with a structure that allows fish passage during critical time periods. The BPA-funded work included sediment removal and restoration of spawning channels in historical spawning areas.

ISRP Specific Comment #5: The effects of harvest must be effectively addressed. The first paragraph of section D (p. 14) says WDFW has worked to reduce harvest but *does not quantify the effect of harvest on the chum populations and effectiveness of the WDFW efforts to restrict harvest. Also, there is a need to clarify what the prospects are for eliminating Lower Columbia River chum harvest (mixed-stock, incidental take?), which would seem necessary if populations are so low.*

WDFW Response:

Refer to the "*Harvest Impacts*" section (page 40) of the WDFW Response to ISRP Request #1 for an overview of the chum Harvest issue. A brief abstract follows:

The Columbia River historically produced large runs of chum salmon that supported a substantial commercial fishery in the last decade of the 19th century and first half of the 20th century. These landings represented an annual harvest of more than 500,000 chum salmon as recently as 1942. Chum spawning escapements have been extremely small since the late 1950s.

Beginning in the mid-1950s, commercial catches declined drastically and in later years rarely exceeded 2,000 per year (NMFS FCRPS BiOp 2000; Appendix C). The total estimated chum escapement in 2002 was just under 20,000. NOAA Fisheries' biological opinions now limit the incidental impact of Columbia River fisheries targeting other species to an expected 2% and not to exceed 5% of the annual return of chum listed under the ESA. No sport or commercial fisheries specifically target chum salmon and the current impacts of 3% or less are incidental to fisheries for other species. Annual reported landings, as incidental take in the late fall mainstem Columbia River fishery, were less than 50 fish from 1994-2000.

Oregon-side Columbia River tributaries have been closed to chum retention since 1992, and most Washington tributaries have been closed to chum salmon fishing since 1995. Further regulatory restrictions have been placed on tributary fisheries through the North of Falcon Process in 2008; i.e., tributary seasons were specifically closed for chum salmon retention in the Cowlitz and Lewis Rivers.

The following table from the LCR FMEP (Vigg and Dennis, editors, 2009) also documents that the incidental landings in mainstem commercial fisheries have remained low (presented as Table 12 the "*Harvest Impacts*" section of this document):

Table 12. Reported incidental catch (landings) of lower Columbia River chum populations in mainstem commercial salmon fisheries (Todd Hillson (WDFW) and Joe Hymer (PSMFC)).

Year	***Incidental Chum Catch – Commercial Landings***
2002	***12***
2003	***6***
2004	***90***
2005	***10***
2006	***3***
2007	***38***

ISRP Specific Comment #6: Even with this lack of references to specific ecological factors leading to stock depletion in the Lower Columbia River, the sponsors provide a very extensive categorized assessment of potential threats to recovery. It has been prepared for every stream in the Washington portion of the Lower Columbia River. The approach is not quantitative but is at least based on ranked responses to recommended actions. *Although the rankings are adequately described, additional support and justification for the assignment of rankings would be beneficial.*

WDFW Response:

With respect to causes for decline and limiting factors – see the response to ISRP Request #1 (Page 18).

With respect to the categorized assessment of potential threats to recovery, refer to the NMFS 2008 FCRPS BiOp.

ISRP Specific Comment #7: On the positive side, the LCFRB has identified a detailed 6-year habitat work schedule (http://www.lcfrb.gen.wa.us/2008%20HWS.htm) for implementation of its habitat restoration strategy. The LCRFB also sponsors community-based work groups to develop and implement watershed specific habitat restoration plans. Much planning at the watershed level has obviously already been conducted. *How will the proposed planning activities complement or add to this previously conducted work?*

WDFW Response:

The planning activities proposed for Project 2008-710-00 will complement the LCFRB work schedule, and WDFW will provide updated information on stock status that will help prioritize and focus work. Please refer to the WDFW responses to ISRP General comment #3 (Page 9 of this document).

ISRP Specific Comment #8: The proposal would benefit by effective presentation of evaluation of results from the many years of previous effort by WDFW and others on habitat improvement and supplementation of chum salmon. For example, in proposal section D, relationships to other projects (p. 14), it is stated: "In 2001, WDFW and the PSMFC received Bonneville Power Administration (BPA) funding (project # 2001-053-00) to construct/restore spawning channels in Duncan Creek and evaluate two reintroduction strategies, recolonization of the channels through release of adult spawners into the channels, and direct plants of hatchery reared fed-fry released at the mouth of Duncan Creek, and natural recolonization via straying." *What are the results, and how do they pertain to the proposed project? A quantitative summary of the results of Duncan Creek, Grays River, and Hood Canal chum salmon supplementation projects is needed if this restoration strategy is going to be proposed for additional locations in the lower Columbia River. This summary should provide evidence of the degree of success of those programs.*

WDFW Response

To date, little information is known about returns to Bonneville area spawning grounds of Duncan Creek project hatchery-origin adults. We are still waiting for complete decoding of otoliths recovered during the falls of 2007 and 2008. As a result, we only have one complete brood year return to look at, the last adults expected from the 2001 brood year returned fall of 2006. Twenty-three females were spawned in 2001, resulting in 45,046 hatchery fed-fry released in spring of 2002, 67 adults were estimated to have returned from this release (all in 2005 as age-4 adults) resulting in a fry-to-adult survival rate of 0.15%.

Information on returns resulting from the adult supplementation at Duncan Creek is not available at this time. Strontium marking of fry produced in the channels was not initiated until 2004 due to permitting issues (the marking is conducted under an Investigative New Animal Drug permit issued by the Food and Drug Administration). The first year of adult returns from 2004 outmigrants would have been 2006, age-3 adults, and no strontium marked otoliths were recoverd that year. However the sample size was extremely small, only 14 of the 456 otoliths recovered came from age-3 adults. Similarly to what was detailed above, otoliths recovered in 2007 and 2008 have not yet been examined for the presence/absence of a strontium mark.

A formal analysis of the Grays River chum salmon supplementation program has not been conducted. This analysis would be completed and reported during the Three-Step review for this hatchery program and included in the Stock Status review of the proposal. However, a quick look at recoveries of hatchery-origin adults during spawning ground surveys and those collected for broodstock, shows a consistent contribution to adult returns (Data from Table 15 of this document is duplicated below):

Percent hatchery-origin spawners recovered during spawning ground surveys and broodstock sampling, Grays River basin.

Year	# Otoliths decoded	# Natural origin (no thermal mark)	# Hatchery origin (thermally marked)	% Hatchery origin	Spawner population estimate
2003	737	665	72	9.77%	16,667
2004	648	638	50	7.72%	14,364
2006	906	826	80	8.80%	6,115

Otoliths from the 2005 spawning season have not been decoded due to lack of funding.

Below are three tables from the Summer Chum Salmon Conservation Initiative Supplemental Report No. 7 - Five-Year Review of the Summer Chum Salmon Conservation Initiative report (http://wdfw.wa.gov/fish/chum/library/chumsupp7.pdf) showing the success of efforts under that conservation plan's supplementation programs for producing adult summer run chum salmon. Especially relevant is the positive changes in population trends and risk ratings when you compare pre- and post-conservation plan time periods.

In addition, there is a paper in press that explored the genetic impacts of supplementation on summer chum in Washington State - Impacts of supplementation: Genetic diversity in supplemented and un-supplemented populations of summer chum salmon (*Oncorhynchus keta*) in Puget Sound (Washington, USA) (Small *et al*, in press). Supplementation was hypothesized as neutral or negative, based on changes during supplementation. Test or measures examined and found to be neutral to most or all populations examined included: heterozygosity, allelic richness, linkage, Hardy-Weinberg equilibrium, N_e, ratio N_e/N, mean relatedness and population structure. Two supplemented populations did show negative effects. However, there were reasons other than supplementation given that could have produced the negative impact (collection anomalies and limitations in hatchery broodstocks imposed by previous and contemporary bottlenecks).

The success, and failures, of these programs will be used to guide the development and implementation of our LCR chum salmon supplementation/reintroduction plan.

Table 2-10. Estimates of total **escapement** of natural and supplementation origin fish returning to streams in Hood Canal and Strait of Juan de Fuca, 2001-2004.

		2001		2002		2003		2004	
Region	Origin	No.	%	No.	%	No.	%	No.	%
Hood Canal	Natural origin	7,170	59.5%	6,853	59.8%	27,319	76.5%	60,296	86.1%
	Supp. origin	4,839	40.2%	4,591	40.1%	8,377	23.5%	9,666	13.8%
	Undetermined origin*	35	0.3%	10	0.1%	0	0.0%	33	0.0%
	Total	12,044		11,454		35,696		69,995	
Strait of Juan de Fuca	Natural origin	1,473	37.2%	4,215	60.6%	4,282	61.5%	5,597	59.9%
	Supp. origin	2,482	62.8%	2,740	39.4%	2,677	38.5%	3,621	38.8%
	Undetermined origin*	0	0.0%	0	0.0%	0	0.0%	123	1.3%
	Total	3,955		6,955		6,958		9,341	
Hood Canal ESU	Natural origin	8,643	54.0%	11,068	60.1%	31,601	74.1%	65,893	83.1%
	Supp. origin	7,321	45.8%	7,331	39.8%	11,054	25.9%	13,287	16.7%
	Undetermined origin*	35	0.2%	10	0.1%	0	0.0%	156	0.2%
	Total	15,999		18,424		42,654		79,336	

* Undetermined origin represents fish escaping to streams where no carcasses were sampled for marks
Estimates may vary slightly from total estimates presented earlier due to rounding error.

Table 2-11. Estimates of total **runsizes** of natural and supplementation origin fish returning to streams in Hood Canal and Strait of Juan de Fuca, 2001-2004.

		2001		2002		2003		2004	
Region	Origin	No.	%	No.	%	No.	%	No.	%
Hood Canal	Natural origin	7,831	58.5%	8,047	61.1%	27,494	76.3%	83,845	88.2%
	Supp. origin	5,509	41.1%	5,103	38.8%	8,429	23.4%	11,199	11.8%
	Undetermined origin*	47	0.4%	20	0.1%	101	0.3%	33	0.0%
	Total	13,375		13,170		36,024		95,077	
Strait of Juan de Fuca	Natural origin	1,483	37.3%	4,231	60.6%	4,317	61.5%	5,608	59.9%
	Supp. origin	2,499	62.7%	2,750	39.4%	2,699	38.5%	3,628	38.8%
	Undetermined origin*	0	0.0%	0	0.0%	0	0.0%	123	1.3%
	Total	3,982		6,981		7,016		9,360	
Hood Canal ESU	Natural origin	9,308	53.6%	12,277	61.0%	31,811	74.0%	89,453	85.7%
	Supp. origin	8,003	46.1%	7,854	39.0%	11,128	25.8%	14,827	14.2%
	Undetermined origin*	47	0.3%	20	0.0%	101	0.2%	156	0.1%
	Total	17,358		20,151		43,040		104,437	

* Undetermined origin represents fish escaping to streams where no carcasses were sampled for marks
Estimates may vary slightly from total estimates presented earlier due to rounding error.

Table 2-17. Mean escapement, effective population size, total population size, population trend, and extinction risk rating for Hood Canal and Strait of Juan de Fuca summer chum stocks for the 4-years preceding onset of recovery actions, and the most recent 4 years. Extinction risk calculations are based on the methodology proposed by Allendorf et al. (1997).

Stock	Escapement (4-year mean)	Effective Population Size (Ne)	Total Population Size (N)	Population Trend	Risk Rating
Union					
1988-1991	391	281	1,406	Stable	Moderate
2001-2004	5,064	3,646	18,230	Increasing	Low
Lilliwaup					
1988-1991	88	63	315	Chronic decline/depression	High
2001-2004	580	418	2,088	Increasing	Moderate
Hamma Hamma					
1988-1991	154	111	555	Chronic decline/depression	High
2001-2004	1,775	1,278	6,390	Increasing	Low
Duckabush					
1988-1991	175	126	631	Chronic decline/depression	High
2001-2004	2,995	2,156	10,780	Increasing	Low
Dosewallips					
1988-1991	234	168	842	Chronic decline/depression	High
2001-2004	5,308	3,822	19,109	Increasing	Low
Big/Little Quilcene					
1988-1991	89	64	319	Chronic decline/depression	High
2001-2004	15,437	11,115	55,572	Stable/increasing	Low
Snow/Salmon					
1989-1992*	283	204	1,018	Precipitous decline	High
2001-2004	5,303	3,818	19,091	Increasing	Low
Jimmycomelately					
1989-1992*	244	176	879	Precipitous decline	High
2001-2004	603	439	2,196	Increasing	Moderate
Dungeness	No data	N/A	N/A	N/A	Special concern

*1989-1992 escapement values used due to later onset of decline of Strait of Juan de Fuca stocks.

ISRP Specific Comment #9: *How likely it is that hatchery supplementation will help the situation?* Hatcheries have clearly had some significant successes in terms of providing fish for harvest in areas farther north. Without a clearer idea of limiting factors in the Lower Columbia River, however, the expanded hatchery supplementation effort might at best be viewed as experimental and at worst as potentially harmful. It is increasingly well established that artificially-reproduced salmon in hatcheries results in decreased in-the-wild reproductive fitness of offspring, often within only one or two generations. *The proposal does not discuss how the FY 2009 development stage of the program will consider this. To what extent may taking wild chum salmon, especially from the low populations, for spawning in hatcheries damage rather than "enhance" wild populations? Elsewhere, a modeling approach (AHA) has been used to assess supplementation options, and that approach may be useful here.*

WDFW Response:

Refer to the limiting factors discussion regarding Hatchery Impacts in WDFW Response to ISRP Request #1 (page 33) and Appendix 7. Hatchery chum populations are less likely to be affected by domestication than other species of salmonids given their short-term culture, i.e., released as fry (HSRG 2008a).

Also see response to ISRP Request #5 (page 60 of this document) and ISRP Request #7 (page 67 of this document) – regarding supplementation impacts on wild fish. WDFW has extensive experience in using the AHA Model, and we will bring in experts from the Science Division (e.g., Andy Appleby and James Dixon), as needed, to model the specific supplementation strategies under consideration prior to implementation.

ISRP Specific Comment #10: Even if the hatchery effort is viewed in a positive way as experimental, the authors of the proposal do not clearly discuss the specific ecological rationale for proceeding with supplementation. The rationale can and should be discussed clearly and succinctly. For example, in Johnson et al. (1997), WDFW discusses the possible interactions between hatchery and wild fish associated with supplementation. It is mentioned that whereas some view the stocking of hatchery fish on top of the wild fish as potentially further depressing wild fish, some evidence suggests that the hatchery fish may buffer the wild fish from excessive predation, i.e. suppressing the effects of depensatory mortality on wild fish at low stock sizes. The hatchery fish may thus protect wild fish at an early vulnerable stage, resulting in more recruitment. None of this rationale and supporting evidence is presented in the proposal to be evaluated and weighed by reviewers for potential benefits and cost to wild fish and to chum stock rebuilding. *As written, the proposal thus seems to be an amalgamation of stock enhancement through a mixed bag of habitat restoration work and hatchery supplementation, with very little indication of how the sponsors view the two main activities as interrelated and how they see the two approaches working together for the rebuilding of chum salmon.*

WDFW Response:

Predation has not been identified in any of the LCR subbasin plans (LCFRB 2004) as a limiting factor for chum populations; therefore a focus on depensatory mortality as a justification for supplementation is not a strong argument. At specific sites, however, predation (fish, bird or mammal) could become a limiting factor as chum abundances increase. Refer to the limiting factors discussion in WDFW Response to ISRP Request #1 and Appendix 4.

See our response to ISRP Request #7 (page 67 of this document)

Also refer to Appendix 6 – LCFRB's (2004) strategy for use of supplementation strategies to rebuild LCR chum stocks.

Also refer to Appendix 7 – HSRG's (2008) strategy for use of conservation hatcheries to rebuild LCR chum stocks.

ISRP Specific Comment #11: A project-relationship question involves the relation between Oregon and Washington recovery efforts. The authors indicate that for Oregon Lower Columbia River salmonid populations, a similar recovery planning process is underway as depicted for WA streams. *Where exactly is Oregon (especially ODFW, but also others) in this habitat evaluation process? No data are presented in Table 5 on the status of Oregon chum salmon, nor is there anything in Table 7 on what monitoring efforts Oregon is planning to undertake. Chum may stray as much or more than some other species as part of their evolved life history strategies, and it is entirely possible that hatchery and monitoring efforts developed will impact Oregon efforts. How do Oregon efforts enter into the proposed activities? How closely are the agencies working together on Lower Columbia River chum issues? Oregon and Oregon stocks are mentioned, but that is the extent of it. The sponsors should indicate how thoroughly Washington and Oregon have coordinated their activities and planning on chum salmon.*

WDFW Response:

See our response to ISRP Request #2 (page 46 of this document); and Appendix 8.

ISRP Specific Comment #12:
2. **Objectives, Work Elements, and Methods (section F)**
Objective 1: Habitat restoration and chum channel site assessment.
This objective is to develop a prioritized list of potential habitat restoration projects. The sponsors list criteria/metrics to be used to rank projects but do not explain methods or reference studies used to calculate these metrics or overall ranking.

WDFW Response:

On page 9 of our original full proposal we provide the following provisional list of criteria and metrics – largely modeled after those used by LCFRB to rank habitat projects:

- Population recovery designation for affected chum salmon population - “primary” or “core” designations (LCFRB and Lower Columbia/Willamette TRT, respectively; (Table 2 of original proposal) should be given priority.
- Quantity/quality of restored habitat provided.
- Life history stage(s) benefitted.
    - Is creation of spawning habitat part of the project?
    - What level of spawner abundance will be supported?
- Documentation of current or historic spawning in the location.
    - Is or was the location used by chum salmon?
- Feasibility/Risk Assessment.
    - How likely is it that the project will be successful?
    - How stable is the location?

  - Build on LCFRB work group and other assessments where available.
- Cost – if estimates are available.
  - Utilize LCFRB and other project lists where available.

We also state in the proposal that "*The criteria/metrics that will be used for ranking habitat restoration and chum channel locations will be finalized prior to assessment…*"

Appendix 5 describes the criteria that will be used by the Lower Columbia Fish Recovery Board (LCFRB) Technical Advisory Committee (TAC) and staff to evaluate habitat protection and restoration project proposals.

In our original proposal, we state:

> "*The intent of this proposal is not to conduct or re-evaluate habitat assessments already completed or compiled through the LCFRB or other processes, but instead to utilize the LCFRB Recovery Plan, existing stream habitat assessments and restoration project lists to develop a prioritized list of habitat restoration projects and/or locations within the LCR that would be the most beneficial to chum salmon.*"

We also refer the reviewers to the WDFW response to ISRP General Comment #3 (page 9) and the section entitled: "*Provisions of the NOAA Fisheries 2008 FCRPS BiOp and the WDFW-Federal Estuary MOA add $90 Million in new Habitat Restoration Work Below Bonneville Dam*". Prioritization of these major ongoing and new BPA-funded habitat restoration efforts will be scoped and prioritized by criteria previously documented by LCFRB, LCREP, and the NOAA Fisheries Estuary Recovery Module (NOAA Fisheries 2007), including the "Draft: Estimated Benefits of Federal Agency Habitat Projects in the Lower Columbia River and Estuary" (FCRPS-BA Attachment B.2.2-3; PC Trask & Associates 2007). In addition, an expert panel will be formed to assist in ranking habitat restoration projects in the LCR and estuary as specified in RPA 35 of the NOAA Fisheries 2008 BiOp (Appendix 9). Project 2008-710-00 will be coordinating closely with all these habitat restoration ranking processes.

The NOAA Fisheries Habitat workgroup (NOAA Fisheries 2007) has developed guidelines and preliminary methodology for estimating biological benefits of habitat restoration projects. A brief summary relevant to chum salmon is presented in the following section.

Estimating Biological Benefits of Habitat Restoration (NOAA Fisheries 2007)

Salo (1991) summarized egg-fry survival rates of chum salmon in his Tables 10 and 11. His summary indicates that egg-fry survivals of naturally produced chum salmon in natural environments can range from 0.1 to 85.9%. The latter is an estimate of survival of chum in the Iski River (tributary to the Amur River in Russia). Since most chum survival estimates in other systems are less than 35%, the Iski River (85.9%) estimate appears to be an outlier. Quinn's (2005) review indicated a mean egg-fry survival of 12.9% for chum salmon.

The following egg-smolt and egg-fry survival estimates appear reasonable if one assumes optimal (100% habitat quality) spawning and rearing conditions (NOAA Fisheries 2007):

- Chinook Salmon: 18% egg-smolt survival
- Steelhead: 4% egg-smolt survival
- Chum Salmon: 35% egg-fry survival

These estimates represent the highest survivals that could be achieved under optimal habitat conditions. The NOAA Fisheries Habitat workgroup also assumed that the maximum pre-spawning adult survival would be 100% at optimal conditions.

Applying these maximum survival rates to optimal habitat conditions resulted in linear functions with different slopes (rates of change) for each species and life stage; refer to Figure 10 for the chum egg to fry survival function and Figure 11 for pre-spawning adult survival. The NOAA Fisheries Habitat Workgroup used the following linear functions to guide professional judgment in estimating survival improvements associated with habitat quality improvements:

- Chinook salmon egg-smolt survival = 0.0018*(Habitat Quality)
- Steelhead egg-smolt survival = 0.0004*(Habitat Quality)
- Chum salmon egg-fry survival = 0.0035*(Habitat Quality)
- Adult pre-spawning survival = 1.0*(Habitat Quality)

These functions provided a conservative approach to estimating survival gains and resulted in estimates that were generally less than those calculated with the Ecosystem Diagnosis and Treatment (EDT) model.

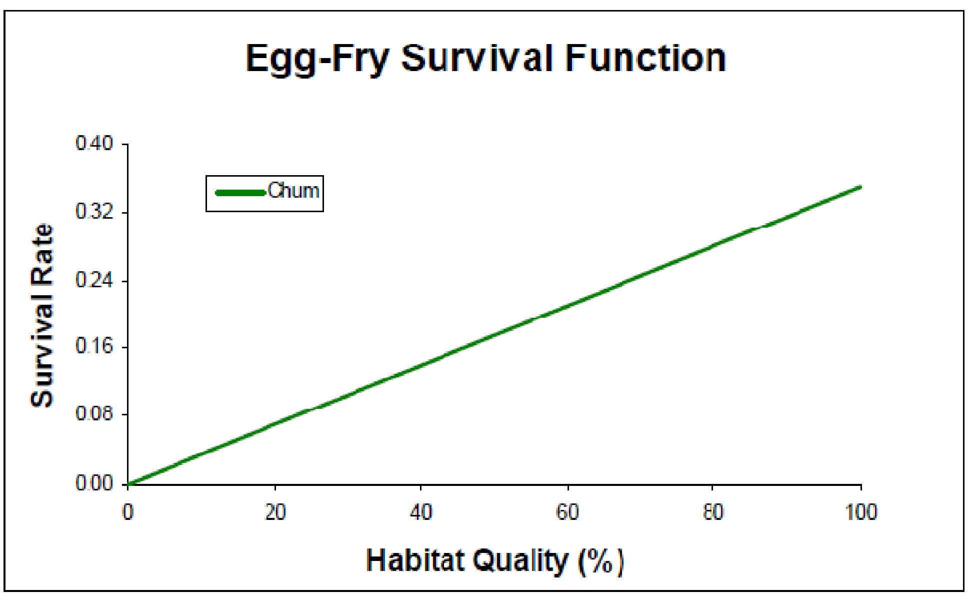


Figure 10. Linear functions for egg-fry survival of chum salmon (NOAA Fisheries RM&E 2007).

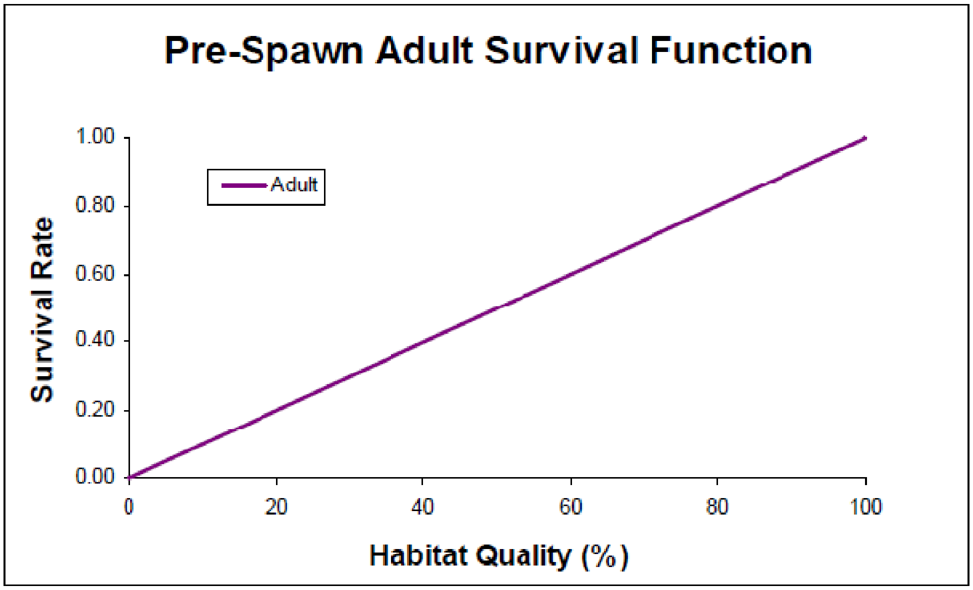


Figure 11. Linear functions for pre-spawning adult survival of chum salmon (NOAA Fisheries RM&E 2007).

Estimate of Potential Biological Benefits of a Proposed Habitat Restoration Project – Chum Spawning Channel to Enhance the Existing I-205 Chum Salmon Population

The following section is an excerpt from Vigg (2009) that illustrates a methodology to estimate the potential biological benefits of a site-specific chum channel. This approach incorporates an egg-to-fry survival function (as in Figure 10, but adjusted to extant data on chum survival functions in spawning channels); and also models the range of potential fry production according to assumptions regarding the following physical and biological parameters:

- Useable length, width and area of the spawning channel;
- Proportion of channel with suitable spawning substrate;
- Fecundity (eggs per female); and
- Sex ratio of spawning population.

The potential chum salmon biological benefits were estimated -- based on the spawning channel characteristics described in the Lower Columbia Fisheries Enhancement Group (LCFEG) conceptual design report (Otak, Inc. 2007) and Columbia River chum salmon biological characteristics (Todd Hillson, Personal correspondence, April 13, 2009). Based on the estimated chum salmon spawning population that could use the spawning channel, the potential chum salmon fry production was projected (Table 16). The total spawning population size supported by this spawning channel would be about 263 females or 526 total spawning adults (range 468-586 spawners) assuming a sex ratio of 1:1 males to female.

The total annual chum production was estimated to be about 340,000 fry (range of 271,547 to 408,240). This estimate is based on the following assumptions:

- The minimum channel bottom area is 8,400 sq-ft – based on a channel that is 6 ft wide and 1400 feet in length;
- Spawning area per female for optimum spawning density is 21.53 to 26.91 square feet (i.e., 2 to 2.5 square meters);
- Assuming that 50% to 75% of the spawning channel would be suitable spawning substrate and therefore utilized for redds – I estimated that 234-293 redds would be produced.
- Given an average fecundity of 3,000 eggs per female (2,900 to 3,100) about 793,068 eggs would be deposited in the redds (range of 678,936 to 907,199); and
- An egg-to-fry survival of 40- 45 percent would result in the estimate of 271,547 to 408,240 chum fry produced per year.

Table 16. Calculations of potential chum fry production derived from the proposed chum spawning channel at Columbia Springs or Woods Landing sties. (Source of Columbia River chum salmon biological characteristics -- Todd Hillson, Personal correspondence, April 13, 2009).

CHUM SALMON SPAWNING ESTIMATE:	VALUE	
	Range	Mid-Point
Estimated length of spawning channel (ft):	--	1,400
Minimum Channel Bottom Area (sq-ft):	--	8,400
Assume Percent of Channel -- Useable (upper %):	75.0%	62.5%
Assume Percent of Channel -- Useable (lower %):	50.0%	
Area of Channel -- Useable (upper sq-ft):	6,300	5,250
Area of Channel -- Useable (lower sq-ft):	4,200	
Females per available area (upper range):	293	263
Females per available area (lower range):	234	
Eggs per Female (upper range):	3,100	3,000
Eggs per Female (lower range):	2,900	
Total Egg Produced (upper range):	907,199	793,068
Total Egg Produced (lower range):	678,936	
Egg-to-Fry Survival (upper-percent):	45.0%	42.5%
Egg-to-Fry Survival (lower-percent):	40.0%	
Total Fry Produced (upper range):	408,240	339,907
Total Fry Produced (upper range):	271,574	

ISRP Specific Comment #13: *Objective 2: Lower Columbia River chum salmon stock status review.*
This objective is to update the Lower Columbia River status review of genetic population structure and abundance. Methods involve DNA (microsatellite analysis and otolith mark analysis of samples collected in 2003-08.) No experimental design/power analysis is provided. There is a "shopping list" of statistical methods for the genetic analysis, but what hypotheses will be tested? Their timeline to have all of the proposed work done by Feb. 2010 does not seem realistic.

WDFW Response:

The February 10 completion date was based on the overly optimistic assumption that Project 2008-710-00 would be authorized to start by March 2009 under FY2009 funding. We have revised this date to July 31, 2010 – assuming an August 1 contract start date. Refer to our response to ISRP Request #4 (page 53 of this document) for a review of the project implementation timeline. Also refer to our response to ISRP Request #3 for a discussion for experimental design (page 47 in this document).

The "shopping list" of statistical methods was taken directly from the methods section of Small *et al.* (2004 and 2006). The 2004 report is attached to this proposal in PISCES. This same author(s) will be conducting the updated genetic analysis. The direction given to them will be to identify and characterize genetic linkages between existing populations of LCR and other nearby (Oregon coast and Willapa Bay) chum salmon populations. To identify, based on genetic analysis, which existing populations could be used as broodstock for supplementation/reintroduction into streams where chum salmon have been or are nearly extirpated (potential donor stocks), and which populations are genetically unique and functioning – for these, native broodstock is preferred for supplementation. This updated analysis will incorporate over 1,000 additional samples, many from small populations that had very little representation in the original analysis, is crucial information for us to to monitor and evaluate supplementation/reintroduction effects.

Small, Maureen P., J.F. Von Bargen, A.E. Frye, and S.F. Young. 2004. Population genetic structure in Lower Columbia River chum salmon (Oncorhynchus keta) inferred from microsatellite DNA. WDFW, unpublished paper.

Small, Maureen P., A.E. Frye, J.F. Von Bargen, , and S.F. Young. 2006. Genetic structure of chum salmon (Oncorhynchus keta) populations in the lower Columbia River: are chum salmon in Cascade tributaries remnant populations? Conservation Genetics (2006) 7:65-78

ISRP Specific Comment #14: *Objective 3: Develop a supplementation/reintroduction strategy for Lower Columbia River chum salmon*. The sponsors propose to develop a “strategy.” It’s not clear what this means or what methods they will use. Completion of this objective seems to rely on completion of Objective 2 – but both will be completed by February 2010. How are Oregon efforts to be melded with the efforts proposed here?

WDFW Response:

Please see General Comment #3 and Figure 1 for a summary of tasks that feed into the development of the supplementation /reintroduction integrated strategy for Lower Columbia River chum salmon. Also refer to our response to ISRP Request #4, Figures 7 and 8 for the implementation schedule.

BPA (Dr. Jeff Gislason, Personal Corrspondence, May 2008), NOAA Fisheries (2007 Proposed Actions; 2008 BiOp RPA’s), and HSRG (2007; 2008) all support the following general supplementation strategy that is central to Project 2008-710-00:

1) Continue the chum reintroduction Projects at Duncan Creek and Grays River;
2) Develop additional pilot reintroduction Projects to implement supplementation strategies in close coordination with ongoing and new habitat restoration activities at specific sites in tributaries below Bonneville Dam.

We refer the reviewers to Table 13 of this document for a summary of benefits; and to HSRG comments on the Duncan Creek and Grays River supplementation programs. The details of WDFW’s Integrated Supplementation Strategy will be developed – based on the latest genetic, demographic, and stock assessment data – during the first year of the project (refer to Figure 1 and Figure 7 of this document).

WDFW is in general agreement with the chum salmon reintroduction and conservation hatchery strategy outlined by the HSRG (2008; see Appendix 7 for more details):

> *“Hatchery intervention can reduce demographic risk by boosting abundance. Additional conservation propagation programs should be promptly initiated within each of the ESU’s three geographic strata to reduce this risk… Chum conservation programs can be rapidly implemented at existing facilities at modest cost. Programs should be sized at 100,000 to 200,000 fry releases. These programs should last up to three generations. Broodstock should be selected from the target population, or in the case of reintroductions, from the most suitable available population… The need for hatchery intervention has been recognized by others and funding appears to be available to pursue chum hatchery programs following more detailed planning … In summary, the use of chum conservation programs should be viewed as an important short-term risk management strategy to preserve the genetic legacy of depressed chum populations.”*

The February 10 completion date was based on the overly optimistic assumption that Project 2008-710-00 would begin by March 2009 under FY2009 funding. We have revised this date to July 31, 2010 – assuming an August 1 contract start date.

ODFW (2009) recently developed a draft recovery strategy for chum salmon in the LCR. Oregon's chum restoration program is not as advanced as Washington's in terms of on-the-ground implementation and conservation of genetic chum strongholds. Oregon's LCR tributary chum populations are considered by ODFW to be functionally extirpated. WDFW plans to assist ODFW to the extent possible – given the depleted status of Washington's chum populations – to provide a genetically compatible donor stock. Refer to Specific Response #2 for more details.

ISRP Specific Comment #15: The literature shows that chum salmon use the estuary for rearing, and habitats in the lower Columbia River and estuary are likely to be important. For example fry from the Duncan Creek population join the lower river/upper estuary just below Bonneville, 140 mi from the river mouth. The sponsors should therefore integrate their strategy with LCREP and other groups concerned with estuarine habitat restoration (in addition to researchers involved in BPA project 20030100 (Historic Habitat Opportunities and Food-Web Linkages of Juvenile Salmon in the Columbia River Estuary and Their Implications for Managing River Flows and Restoring Estuarine Habitat). A balanced restoration program that provides rearing as well as spawning habitat is required if supplementation/ reintroduction is chosen as a strategy.

WDFW Response:

We agree with the ISRP statement (above) and through the BPA-Corps-WDFW Estuary MOA plan to integrate our Supplementation Strategy (that will be fully developed during the first year of the Project 2008-710-00) with LCFRB and LCREP. We have been coordinating with Dan Bottom -- the principal investigators of BPA Project 2003-01-00; In fact, funding for the Grays River Supplementation project during 2007-08 was obtained from NOAA Fisheries with the support of Dr. Bottom. Chum salmon produced at Grays River Hatchery were used to assess habitat restoration efforts in the Lower Grays river and CR Estuary. In addition, the current juvenile outmigrant monitoring program on the Grays River is partially funded through 2009 by Dr. Bottom's project via NOAA BiOp funds.

ISRP Specific Comment #16: The strategy should also consider limiting factors in the northeast Pacific Ocean.

WDFW Response:

NMFS (2008) stated that ocean conditions and climate are considered neutral for the short term – and are not limiting factors (Appendix 4):

> *"Analyses of lower Columbia River salmon and steelhead status generally assume that future ocean and climate conditions will approximate the average conditions that prevailed during the recent base period used for status assessments. Recent conditions have been less productive for most Columbia River salmonids than the long-term average. Although climate change will affect the future status the ESU to some extent, future trends, especially during the time period relevant to the Prospective Actions, are unclear. Under the adaptive management implementation approach of the Lower Columbia River Recovery and Subbasin Plan, further reductions in salmon production due to long-term ocean and climate trends will need to be addressed through additional recovery effort (LCFRB 2004)."*

Changing oceanic conditions appear uncorrelated with Hood Canal/Strait of Juan de Fuca chum salmon abundance (WDFW, unpublished data; Edmund Casillas NOAA, personal communication; Small *et al.* in press). Chum salmon out-migrate very young and initial juvenile survival may be unaffected by changes associated with decadal oscillations.

ISRP Specific Comment #17: *Objective 4: Population monitoring and evaluation program development*. This objective needs to be tied to the subbasin plans and the Fish and Wildlife Program. The experimental design explanation is insufficient. The ISRP suggests that the sponsors work with a specialist to develop a statistically valid design for population estimation (Objectives 2 and 4).

WDFW Response:

Yes, we are planning to coordinate with WDFW Science Division staff – Dr. Steve Schroder, Dr. M. Small, Dr. Chris Ryding and Mr. Dan Rawding – for the development of a statistically valid design for population abundance and population genetics assessment. Refer to our original proposal for resumes of key personnel.

Also, refer to our response to ISRP Request #3 – we describe the development of the study design during the first year of the project. The LCFRB (2004) will provide the foundation for the M&E plan.

ISRP Specific Comment #18: *Objective 5: Grays River chum salmon supplementation*. Is this program successfully producing adult returns?

WDFW Response:

Yes, see text and Table 15 on page 72 of this document. Also, refer to our response to ISRP Request #7a.

ISRP Specific Comment #19: Objective 6: The authors indicate that proposed vegetation removal in Hamilton spring channel will be evaluated by comparing the pre- and post-treatment percent of open spawning area/gravel. The pre-treatment condition will be documented by determining the percent of total wetted area within the spawning channel that is covered by vegetation. A post-treatment survey will be done and the change in percent area covered will be used to measure the success. A more meaningful evaluation would involve assessment of spawners as the key response factor in the evaluation. A plan for such an evaluation is required.

WDFW Response:

Hamilton Spring Channel is a man-made spawning channel; large-scale maintenance was last performed in the late 1990's by WDFW. USFWS performed annual vegetation removal in and along the spawning channel when they had a contract with BPA to evaluate chum salmon spawning in that area, but no such activities have been conducted for the last three years. Non-native vegetation removal was not part of our original proposal, and was added at BPA's request (see page 2). We viewed this work as on-going maintenance and proposed to evaluate this task by documenting the amount of area cleared of non-native vegetation. We agree that a "spawner response" evaluation would be more valuable for determining the benefit to chum of vegetation removal in Hamilton Spring Channel; however, it is beyond the scope, and budget of our proposed work in FFY09.

ISRP Specific Comment #20: *Objective 7: Initiate Three-Step Review for at least one top-ranked project identified by the habitat restoration and chum channel site assessment*. No schedule or methods are provided and are required for review.

WDFW Response:

The NPCC Three-Step review process is well defined, and we will follow the guidelines and schedule presented in the NPCC, November 2006, document 2006-21 (http://www.nwcouncil.org/library/2006/2006-21.pdf). The following excerpt describes the conditions that trigger a Review:

When the Council recommends a proposal as part of a funding recommendation, it will also identify which of the following triggers applies to direct the project into the step review. This will occur as a comment as part of the funding recommendations to Bonneville in association to a particular solicitation.

A. Artificial Production Initiatives
Production initiatives will trigger a review when a project proposes any one of the following: (a) construct significant new production facilities; (b) begin planting fish in waters they have not been planted in before; (c) increase significantly the number of fish being introduced; (d) change stocks or the number of stocks, and/or (e) change the location of production facilities. It also includes initiation of funding existing facilities that were formerly funded otherwise.

B. Other Project Initiatives
For other projects the Council may request a review based on the following triggers: (a) construct a facility that costs more than $1,000,000 during the fiscal year; (b) phased engineering designs are required for contractual purposes; (c) proposed actions address the entire watershed; (d) action is a multi-agency and multi-contractual effort, (e) new proposal that is outside the current solicitation and review cycle, (f) additional review or fix-it-loop is requested, and/or (g) the action is a substantial deviation from the adopted subbasin plan.

Our expectation is that reintroduction programs involving the supplementation of chum via artificial propagation will require a Three-Step Review. Our intent is to complete a combined Three-Step Review for the existing Grays River Supplementation project in Year 1. In Year 2, additional Three-Step Reviews for supplementation projects linked to top-ranked habitat projects identified for implementation will also be initiated. In these cases, concurrent implementation of habitat and supplementation projects is desired to provide the most rapid fish response to newly created/improved habitat. It should be noted that we do not expect to build any new production facilities under this project. A complete timeline for Performance Year 1 and 2 is described in our response to ISRP Request #4; Figures 7 and 8.

ISRP Specific Comment #21: 3. **M&E (section G, and F)**
Among the five "groundwork" components listed for FY 2009, the emphasis for the years of program operation may be on items (3) Adaptive management of existing supplementation programs, including continuation of the Grays River program, and (4) Development of a stepwise enhancement program that utilizes supplementation / reintroduction to rebuild Lower Columbia River chum populations. The amount of staff time and other resources (and budget) allotted each of the five groundwork components is not shown.

WDFW Response:

Again, this question appears to be a result of the limited information provided in the narrative template used for the ISRP review (see page 3 of this document for a full discussion). The template did not contain a section header asking for staffing and budget information; this information was contained in our complete proposal submitted to BPA and in PISCES. Our template submission only included tasks to be completed in FFY09 and a very rough outline of FFY 10 activities.

The completed line-item budget for FFY09 from our proposal details staffing levels (Table 17), and Table 18 details spending by Work Elements that we identified for FFY09 in PISCES.

At this time, we are still unable to provide detailed out-year staffing levels and budget amounts since they will be heavily influenced by both BPA funding decisions and the scale of individual projects developed under this program, all of which are currently unknown. We propose to develop this information in Year 1 of the project in conjunction with completion of the deliverables outlined in the proposal.

Table 17. Proposed staff levels and cost for FFY09

Fish Biologist 3	**6**	**mo.**	**@**	**$4,770**	**/mo.**	**$28,620**
Fish Biologist 4	3	mo.	@	$5,010	/mo.	$15,030
Fish and Wildlife Research Scientist 2	1	mo.	@	$6,257	/mo.	$6,257
Natural Resource Scientist 3	3	mo.	@	$5,668	/mo.	$17,004
Fish Biologist 3	1	mo.	@	$4,653	/mo.	$4,653
Fish Biologist 2	3	mo.	@	$4,214	/mo.	$12,642
Scientific Tech 1	2	mo.	@	$2,318	/mo.	$4,636
Scientific Tech 3	1.55	mo.	@	$3,631	/mo.	$5,628
Fish Biologist 4	1	mo.	@	$5,010	/mo.	$5,010
Fish Biologist 1	1	mo.	@	$2,663	/mo.	$2,663
		Benefits	@	32.2%	regular	$32,863
		Total				135,006

Table 18. Cost estimates for FFY09 Work Elements

Environmental compliance documents for Grays River chum salmon supplementation	$1,000
Habitat restoration and chum channel site assessment	$20,000
Lower Columbia River (LCR) chum salmon stock status review	$115,000
Grays River chum supplementation program	$35,000
Council Three-Step process for Grays River chum salmon supplementation	$13,000
Future supplementation/reintroduction strategy development	$35,082
Population monitoring and evaluation program development	$35,000
Hamilton Spring Channel - remove canary reed grass	$8,000
Manage and administer project	$1,000
Submit Progress Reports	$1,000
Periodic Status Reports for BPA	$1,000

ISRP Specific Comment #22: "Effectiveness monitoring" is mentioned once on page 7 and twice on page 19, but the proposal never says what this category of monitoring is nor what it will measure nor how it will be conducted.

WDFW Response:

Refer to General Response #4 (page #15) and WDFW Response to ISRP Request #6 (page 63) and the Glossary in the revised proposal.

ISRP Specific Comment #23: Page 8—Table 4: The terms "primary" and "core" are used without definition. Word search can find definition for "primary" buried in the last paragraph of page 14, and, although "core" is mentioned as an LCFRB and TRT designation in item 1 on page 16, the term does not seem to be explained anywhere in the proposal.

WDFW Response:

Refer to General Response #4 and the Glossary in the revised proposal.

References

Allendorf, F.W., D. Bayles, D.L. Bottom, K.P. Currens, C.A. Frissell, D. Hankin, J.A. Lichatowich,W. Nehlsen, P.C. Trotter, and T.H. Williams. 1997. Prioritizing Pacific salmon stocks for conservation. Conservation Biology 11.1:140-152.

Ames J. and K. Adicks. 2003. Chum Salmon Supplementation: Ban or Boon?. Proc.of the Twenty-first Northeast Pacific Pink and Chum Salmon Workshop. Depart. Fisheries and Oceans. Vancouver, B.C. Canada.

Ames, J., G. Graves, and C. Weller. 2000. Summer chum salmon conservation initiative: An implementation plan to recover summer chum in the Hood Canal and Straight of Juan De Fuca Region. Washington Department of Fish and Wildlife and Point-No-Point Treaty Tribes.

Anderson, J. L., R. W. Hilborn, R. T. Lackey, and D. Ludwig. 2003. Watershed restoration— adaptive decision making in the face of uncertainty. Pages 203-232 in R. C. Wissmar and P. A. Bisson, editors. Strategies for restoring river ecosystems: sources of variability and uncertainty in natural and managed systems. American Fisheries Society, Bethesda, Maryland, USA.

Andrew and Geen. 1960. Sockeye and pink salmon production in relation to proposed dams in the Fraser River system. International Pacific Salmon Commission, Bulletin 11: page 110.

Anonymous-ICTRT. 2004. Viability Criteria: Summary of Approach and Preliminary Results. (Draft) July 8, 2004. Interior Columbia Basin Technical Recovery Team, NOAA, NMFS. 15 p.

Anonymous-ICTRT. 2005. Interior Columbia Basin TRT: Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. NW Fish. Sci. Center, USDC NOAA National Marine Fisheries Service, 2725 Montlake Blvd. E., Seattle WA 98112. 49 p.

Anonymous-ICTRT. 2007. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Review Draft. Interior Columbia Basin TRT, NW Fish. Sci. Center, USDC NOAA National Marine Fisheries Service, 2725 Montlake Blvd. E., Seattle WA 98112. 49 p.

Araki, H., Cooper, B., and Blouin, M.S. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science **318**:100-103.

Brenkman, S. J., S. C. Corbett, and E.C. Volk. 2007 Use of otolith chemistry and radiotelemetry to determine age-specific migratory patterns of anadromous bull trout in the Hoh River, Washington. Trans. Am. Fish. Soc. 136, 1-11

Bruya, K.J. 1981. The use of different gravel depths to enhance the spawning of chum salmon, *Oncorhynchus keta*. M.S. thesis. University of Washington, Seattle, Washington. 86 p.

Bryant, F.G. 1949. A survey of the Columbia River and its tributaries with special reference to the management of its fisheries resources. No. 2. Washington streams from the mouth of the Klickitat to and including the Klickitat River (Area I). U.S. Fish & Wildlife Service. Special Report No. 62. 110 pp. illus.

Burner, C.J. 1951. Characteristics of spawning nests of Columbia River salmon. Fisheries Bulletin, Fish and Wildlife service 61:97-110.

CBFWA (Columbia Basin Fish & Wildlife Authority). 2009. The Status of the Resource (SOTR) Draft Report. Columbia Basin Fish & Wildlife Authority. May 27, 2009. Portland, Oregon. (source: http://www.cbfwa.org/committee_main.cfm)

Chapman, D.W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Transactions of the American Fisheries Society 115:662-670.

Craig, J.A. and R.L. Hacker. 1940. The history and development of the fisheries of the Columbia River. U.S. Bureau of Fisheries. Bulletin 49(32): 133-215.

Crawford, B. A. and S. Rumsey. 2009. Guidance For Monitoring Recovery of Salmon and Steelhead Listed Under the Federal Endangered Species Act (Idaho, Oregon, and Washington). Draft – April 27, 2009. NOAA Fisheries Service – Northwest Region. 125 pages.

Crawford, B.A. (ed.) 2007. Washington State Framework for Monitoring Salmon Populations Listed under the Federal Endangered Species Act and Associated Freshwater Habitats. WA Gov. Forum on Monitoring Salmon Recovery and Watershed Health, Olympia WA.

Drivdahl, C. (ed.) 2006. 2006 State of Salmon in Watersheds. State of Washington Governor's Salmon Recovery Office. 101 p.

Ford, M.J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conserv. Biol. **16**(3): 815-825.

Fresh, K.L., R.D. Cardwell, B.P. Snyder, and E.O. Salo. 1980. Some hatchery strategies for reducing predation upon juvenile chum salmon (*Oncorhynchus keta*) in freshwater. Pages 79 - 89 *In:* Proceedings of the North American Aquaculture Symposium. Alaska Dept. Of Fish and Game. Anchorage, Alaska.

Fulton, L. A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River basin—past and present. Special Scientific Report—Fisheries 618.

Gardner, A. and West, S.A. 2004. Spite and the scale of competition. J. Evol. Biol. **17**:1195-1203.

Goodman, D. 2004. Salmon supplementation: demography, evolution, and risk assessment. *In* Propagated Fish in Resource Management. *Edited by* M.J. Hedrick, P. 2005. Large variance in reproductive success and the N_e/N ratio. Evolution **59**(7): 1596-1599.

Groot, C., and Margolis, L. 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver, B.C., Canada.

Hilborn, R. 1992. Institutional learning and spawning channels for sockeye salmon (Oncorhynchus nerka). Canadian Journal of Fisheries and Aquatic Sciences. 49:1126-1136.

Hillson, T. D. 2002. Re-Introduction of Lower Columbia River Chum Salmon into Duncan Creek Annual Report for 2002, Report to Bonneville Power Administration, Contract No. 00007373, Project No. 200105300, 63 electronic pages (BPA Report DOE/BP - 00007373 -1)

Hillson, T. D. 2003. Reintroduction of lower Columbia River chum salmon into Duncan Creek, 2002-03 annual report. *Prepared by* Washington Department of Fish and Wildlife for Bonneville Power Administration (BPA Report DOE/BP-00007373-2).

Hillson, T. D. 2004. Reintroduction of lower Columbia River chum salmon into Duncan Creek, 2003-04 annual report. *Prepared by* Washington Department of Fish and Wildlife for Bonneville Power Administration (BPA Report DOE/BP-00007373-4).

Hillson, T. D. 2007. Reintroduction of lower Columbia River chum salmon into Duncan Creek, 2005-06 annual report. *Prepared by* Washington Department of Fish and Wildlife for Bonneville Power Administration (BPA Report DOE/BP-00029512-1).

Howell, P., K. Jones, L. Scarnecchia, L. LaVoy, W. Kendra, and D. Ortmann. 1985. Lower Columbia River chum (wild and hatchery). Pages 528-537 *in* Stock Assessment of Columbia River Anadromous Salmonids; Volume I: Chinook, Coho, Chum and Sockeye Salmon Stock Summaries. Project No. 83-335, final report. Bonneville Power Administration.

HSRG (Hatchery Scientific Review Group). 2008a. Summary of HSRG Findings for Chum Populations in the Lower Columbia River and Gorge. March 11, 2008. Hatchery Scientific Review Group.

HSRG (Hatchery Scientific Review Group). 2008b. Review and Recommendations Chum Salmon Population and Related Hatchery Programs. Final. October 8, 2008 Hatchery Scientific Review Group http://www.hatcheryreform.us/mfs/reports/system/welcome_show.action

HSRG (Hatchery Scientific Review Group). 2008c. Columbia River Chinook Salmon Hatchery Analysis: Volume 1. (Draft) Hatchery Scientific Review Group. (218 pages) http://www.hatcheryreform.us/mfs/reports/system/welcome_show.action

Hymer, J. 1994. Estimating the Natural Spawning Chum Population in Hardy Creek 1957-93. Washington Department of Fisheries. Columbia River Laboratory Progress Report #94-11.

Johnson O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997 Status review of chum salmon from Washington, Oregon, and California. National Marine Fisheries Service. Seattle, Washington.

Johnson, R.C., R.J. Gerke, D.W. Heiser, R.F. Orrell, S.B. Mathews, and J.G. Olds. 1971. Pink and chum salmon investigations, 1969: supplementary progress report. Washington Department of Fisheries, Fisheries Management and Research Division, Olympia, Washington. 66 p.

Johnson, T.H., C. Weller and T. J. Tynan. 2003. Ongoing supplementation programs for summer chum salmon in the Hood Canal and Strait of Juan de Fuca regions of Washington State. Proc.of the Twenty-first Northeast Pacific Pink and Chum Salmon Workshop. Depart. Fisheries and Oceans. Vancouver, B.C. Canada.

Kostow, K. (editor). 1995. Biennial report on the status of wild fish in Oregon. Internal Rep., Oreg. Dep. Fish Wildl., P.O. Box 59, Portland, OR 97207.

Lawson, P.W., E. Bjorkstedt, M. Chilcote, C. Huntington, J. Mills, K. Moore, T. Nickelson, G.H. Reeves, H.A. Stout & T.C. Wainwright. 2004. Identification of Historical Populations of Coho Salmon (Oncorhynchus Kisutch) in the Oregon Coast Evolutionarily Significant Unit. (Review Draft) Oregon-N. California Coast Tech. Recov. Team, USDC NOAA National Marine Fisheries Service, CZES Div., NW Fish. Sci. Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.

LCFRB. Lower Columbia Fish Recovery Board, 2004. Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan. http://www.lcfrb.gen.wa.us/recovery%20planning%20overview.htm

Marshall, Anne. 2001. Memo to Joe Hymer. Columbia River Main Stem Chum Genetic Sampling.

McClure, M., B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000a. A standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Cumulative Risk Initiative, Draft Report, Seattle, Washington. April 7.

McClure, B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000b. Revised Appendix B of standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. September.

McClure, M. M., B. L. Sanderson, E. E. Holmes, and C. E. Jordan. 2000c. A large-scale, multispecies risk assessment: anadromous salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. Submitted to Ecological Applications.McElhany P., M.H. Ruckelshaus, M.J. Ford, T.C.Wainright and E.P Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. NW Fisheries Science Center. - Seattle,WA : NOAA Fisheries Service, 2000. - p. 156 p.. - NOAA Tech. Memo. NMFS-NWFSC-42.

McElhany, P., T. Backman, C. Busack, S. Kolmes, J. Myers, D. Rawding, A. Steel, C. Steward, T. Whitesel, and C. Willis. 2004. Status Evaluation of salmon and steelhead populations in the Willamette and Lower Columbia River Basins. Willamette/Lower Columbia Technical Recovery Team. Northwest Fisheries Science Center, NOAA Fisheries, Seattle, Washington.

McElhany, P. 2005. Columbia River chum salmon ESU. *in* T. P. Good, R. S. Waples, and P. Adams, editors. Updated status of federally listed ESUs of west coast salmon and steelhead. NOAA, Seattle, WA.

McElhany, P., C. Busack, M. Chilcote, S. Kolmes, B. McIntosh, J. Myers, D. Rawding, A. Steel, C. Steward, D. Ward, T. Whitesel & C. Willis. 2006. Revised Viability Criteria for Salmon and Steelhead in the Willamette and Lower Columbia Basins. April 1, 2006. Cons. Biol. Div., NW Fish. Sci. Center, USDC NOAA National Marine Fisheries Service, Seattle, WA 98112-2097.

McElhany, P., M. Chilcote, J. Myers, and R. Beamesderfer. 2007. Viability Status of Oregon Salmon and Steelhead Populations in the Willamette and Lower Columbia Basins Part 3: Columbia River Chum. Report prepared for the Oregon Department of Fish and Wildlife and the National Marine Fisheries Service.

Muldoon, A., J. Youngers, and E. Ollerenshaw. 2001. 2000 Oregon Lower Columbia River spawning ground survey results. Oregon Department of Fish and Wildlife. Columbia River Management, Clackamas, Oregon.

Neave, F., T. Yonemori, and R. Bakkala. 1976. Distribution and origin of chum salmon in offshore waters of the North Pacific Ocean. International North Pacific Fish Commission Bulletin 35:79 p.

Nickum, P.M. Mazik, J.G. Nickum, and D.D. MacKinlay. American Fisheries Society Symposium **44**. Bethesda, Maryland. pp. 217-232.

NOAA Fisheries Service. 2006. Pacific Coastal Salmon Recovery Fund Performance Goals, Measures, and Reporting Framework. - Seattle, WA : NOAA Fisheries Service, December 2006.

NOAA Fisheries Service. 2007. Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance. Seattle, WA. Northwest Region and Fisheries Science Center, May 2007.

NOAA Fisheries Service. 2008a. Draft Artificial Propagation of Pacific Salmon: Assessing Benefits and Risks and Recommendations for Planning and Operating Hatchery Programs. Salmon Recovery Division. - Portland, OR : US Dept. of Commerce NOAA's National Marine Fisheries Service.

NOAA Fisheries Service. 2008b. Cumulative effects analysis of the FCRPS Biological Opinion. Chapter 8 Effects Analysis for Salmonids. Section 8.9 Columbia River Chum Salmon. May 5, 2008.

North, J. M. Miller, J. Sewall, T. Jones, A. Dietrichs, and T. Miethe. 2006. Select Area Fishery Evaluation Project, Final Project Report, October 1993 – October 2005. Prepared for: U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

NPPC (Northwest Power Planning Council). 1984. The Columbia Basin Fish & Wildlife Program. Northwest Power Planning Council. Portland, Oregon.

NPPC (Northwest Power Planning Council). 1986. Council staff compilation of information on salmon and steelhead losses in the Columbia River basin. Northwest Power Planning Council. Portland, Oregon. (Cited in Chapman 1986)

Northwest Power Planning Council et al. 1990. Grays River Subbasin salmon and steelhead production plan. Washington Department of Fisheries, Olympia. 70 p.

ODFW (Oregon Department of Fish and Wildlife). 2009. Draft Oregon Lower Columbia River Recovery Plan for Salmon and Steelhead - Appendix 7-C: Columbia River Chum Salmon Recovery Strategy for Oregon's Lower Columbia River Coastal Stratum Tributaries April 22, 2009. Salem, Oregon.

ODFW (Oregon Department of Fish and Wildlife). 2005. 2005 Oregon native fish status report. Volume II. Assessment methods and population results. Oregon Department of Fish and Wildlife. Salem, Oregon.

Otak, Inc. 2007. Columbia Springs chum salmon spawning channel conceptual design report. Submitted to Lower Columbia Fisheries Enhancement Group (LCFEG). Vancouver, WA. May 7. 2007. 10 Pages + Appendices. Prepared by Otak, Inc. Kirkland, WA.

PC Trask & Associates. 2007. Draft: Estimated benefits of Federal agency habitat projects in the Lower Columbia River and Estuary. Prepared for the Policy work Group of the FCRPS Remand. Attachment B.2.2-3.

PFMC (Pacific Fishery Management Council. 1979. Freshwater habitat, salmon produced, and escapement for natural spawning along the Pacific Coast of the United States. Report to the Anadromous Salmonid Environmental Task Force, Portland, Oregon.

Phelps, S.R., L.L. LeClair, S. Young, and H.L. Blankenship. 1994. Genetic diversity patterns of chum salmon in the Pacific Northwest. Canadian Journal of Fisheries and Aquatic Sciences. 51 (Supplement 1), 65-83.

Powers, P.D., and J.F. Osborn 1985. Analysis of barriers to upstream fish migration: an investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Final project report, part 4 of 4, Project 82-14. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Portland, Oregon. 120 p.

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press, Seattle, WA.

Rawding, D. and T. D. Hillson. 2003. Population estimates for chum salmon spawning in the Mainstem Columbia River, 2002. Project 2001-05300, 47 electronic pages, (BPA Report DOE/BP-00007373-3) http://www.efw.bpa.gov/Publications/A00007373-3.pdf

Rawding, D., T. Hillson, B. Glaser, K. Jenkins, and S. VanderPloeg. 2006. Abundance and Spawning Distribution of Chinook Salmon in Mill, Abernathy, and Germany Creeks during 2005. Wash. Dept. of Fish and Wild. Vancouver, WA. 37pp.

Rich, W.H. 1948. A survey of the Columbia River and its tributaries with special reference to the management of its fisheries resources. No. 1. Introduction. U.S. Fish & Wildlife Service. Special Report No. 51. 26 pp. illus.

Roler, R. 2002. Grays River Subbasin Summary *draft*. Washington Department of Fish and Wildlife. Prepared for the Northwest Power Planning Council.

Ruckelshaus, M.H., K.P. Currens, R.R. Fuerstenberg, W.H. Graeber, K. Rawson, N.J. Sands & J.B. Scott. 2002. Planning Ranges and Preliminary Guidelines for the Delisting and Recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit. USDC NOAA National Marine Fisheries Service, NW Fish. Sci. Center, 2725 Montlake Blvd. E., Seattle WA 98112. 17 p.

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands & J.B. Scott. 2006. Independent populations of Chinook salmon in Puget Sound. Tech. Memo: NMFS-NWFSC-78. Dept. Commer., USDC NOAA National Marine Fisheries Service, NW Fish. Sci. Center, 2725 Montlake Blvd. E., Seattle WA 98112. 125 p.

Rukhlov, F.N. 1969. 1982. The role of salmon production and the perspectives of its development in the Sakhalin region, p 99-103. In: B.R. Metcalf and R.A. Neve (editors). Proceedings of the North Pacific Aquaculture Symposium. Alaska Sea Grant Report 82-2.

Ryman, N., and Laikre, L. 1991. Effects of supportive breeding on the genetically effective population size. Conserv. Biol. **5**: 325-329.

Salo, E.O. 1991. Life history of chum salmon (*Oncorhynchus keta)*. Pages 231 - 310 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, Univ. British Columbia, Vancouver, British Columbia

Sano, S., and A. Nagasawa. 1958. Natural propagation of chum salmon, *Oncorhynchus keta*, in Memu River, Tokachi. Scientific Report of the Hokkaido Salmon Hatchery 12:1-19. (translation: Fish. Res. Bd. Canada Tranls. Ser. 198).

Schroder, S.L. 1973. Effects of density on the spawning success of chum salmon (*Oncorhynchus keta*) in an artificial spawning channel. M.S. Thesis, Univ. Washington, Seattle. 78 pp.

Schroder, S.L. 1977. Assessment of production of chum salmon fry from the Big Beef Creek spawning channel. Completion Rep. Anadromous Fish Project AFC-67. Fish. Res. Inst., Univ. Washington, FRI-UW-7718. 77pp.

Schroder, S.L. 2000. Monitoring and evaluation plan for Duncan Creek chum Salmon reintroduction plan. Washington Department of Fish and Wildlife, unpublished paper.

Schroder, S. and J. Ames. 2004. Summer chum conservation initiative: An Implementation plan to recover summer chum salmon in the Hood Canal and Strait of Juan de Fuca region. Supplemental Report No. 6, Washington Department of Fish and Wildlife.

Small, M.P., A.E. Frye, J.F. Von Bargen, and S.F. Young. 2006. Genetic Structure of chum salmon (Oncorhynchus keta) populations in the lower Columbia River: are chum salmon in Cascade tributaries remnant populations? Conservation Genetics 7:65-78.

Small M. P., Beacham T., Withler R. and Nelson R. J. 1998. Discriminating coho salmon (Oncorhynchus kisutch) populations within the Fraser River, British Columbia using microsatellite DNA markers, Mol. Ecol., 7, 141-155.

Small, M. P., J.F. Von Bargen, A.E. Frye, and S.F. Young. 2004. Population genetic structure in Lower Columbia River chum salmon (Oncorhynchus keta) inferred from microsatellite DNA. WDFW, (unpublished paper).

Small, M.P., Currens, K., Johnson, T.H., Frye, A.E., and J.F. Von Bargen. (unpublished manuscript) Impacts of supplementation: Genetic diversity in supplemented and unsupplemented populations of summer chum salmon (*Oncorhynchus keta*) in Puget Sound (Washington, USA) Molecular Genetics Laboratory, Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA, 98502, USA

Smith, H.M. 1895. Notes on the reconnaissance of the fisheries of the Pacific Coast of the United States in 1894. U.S. Fish Commission Bulletin 14:223-288. (Cited in Chapman 1986)

USACE (U.S. Army Corps of Engineers). 2009. 2008 Annual Fish Passage Report Columbia and Snake Rivers for salmon, steelhead, shad and lamprey. Prepared By: U.S. Army Engineer Districts: Portland and Walla Walla. 203 pages.

Volk, E.C., S.L. Schroder, and J.J. Grimm. 1999. Otolith thermal marking. Fisheries Research 43: 205-219.

Vigg, S. 2009. Potential biological benefits of the proposed property acquisition and habitat restoration at Woods Landing/Columbia Springs – to provide additional chum salmon spawning and a cold-water refuge for all summer and fall-migrating salmonids. Washington Department of Fish & Wildlife. Vancouver, WA.

Vigg, S. and M. Dennis (editors). 2009. Lower Columbia River (LCR) Fishery Management and Evaluation Plan (FMEP) and Coho Supplement Annual Report, 2008 and five-year comprehensive update – 2002 – 2007. March 5, 2009. Washington Department of Fish & Wildlife, Fish Program, Fish Management and ESA Divisions, Olympia, Washington. 64 pp.

Waples, R.S. 1991. Pacific Salmon, Oncorhynchus spp., and the Definition of "Species" Under the Endangered Species Act. Marine Fisheries Review 53: 11-22.

WDFW (Washington Department of Fish and Wildlife). 2008. Statewide Steelhead Management Plan: Statewide Policies, Strategies, and Actions. WA Dept. Fish & Wildlife, 600 Capitol Way N., Olympia WA 98501-1091. 42 p.

WDFW (Washington Department of Fish and Wildlife). 2004. Draft Grays River/Sea Resources chum salmon hatchery genetic management plan. WDFW. Olympia, Washington.

WDFW (Washington Department of Fish and Wildlife). 2004. Draft Washougal Hatchery Chum Salmon Program Hatchery Genetic Management Plan. WDFW. Olympia, Washington. Last Updated August 13, 2004

WDFW/ODFW (Washington and Oregon Departments of Fish and Wildlife). 2002. Columbia River Fish Runs and Fisheries, 1938-2002.

Yaffee, S., S. Schueller, S. Higgs, A. Dotzour and J. Wondolleck. 2004. Measuring Progress: An Evaluation Guide for Ecosystem and Community-Based Projects. Ecosystem Management Initiative, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI.

Appendix 1. Glossary of Terms.

1.1 Types of Monitoring – Definitions (Source NMFS 2008)

Following are commonly used definitions for the most general types of monitoring with relevance to recovery plan implementation and assessment. These definitions allow for distinctions between status and trends monitoring, and parse out the components of effectiveness monitoring into implementation, compliance, effectiveness, and validation. To simplify the discussion, these five monitoring types have been lumped into two functional groups: those involved in baseline descriptive monitoring and those involved in cause-and-effect assessment of actions.

Baseline descriptive monitoring

Status Monitoring – Status monitoring is used to characterize existing or undisturbed conditions and to establish a baseline for future comparisons. The intent of status monitoring is to capture temporal and spatial variability in the parameters of interest.

Trend Monitoring – Trend monitoring involves measurements taken at regular time or space intervals to assess the long-term or large-scale trend in a particular parameter. The measurements are usually not taken specifically to evaluate management practices; they serve instead to describe changes in the parameter over time or space.

Implementation Monitoring – Implementation monitoring determines whether activities were carried out as planned, and is generally carried out as an administrative review or site visit. This type of monitoring cannot directly link restoration actions to physical, chemical, or biological responses, as none of these parameters are measured. For example, if a restoration action is initiated to fence 20 miles of stream with the hope of reducing stream temperature and fine sediment input from run-off and bank erosion, the implementation monitoring would consist of confirming the presence of the fence.

Compliance Monitoring – Compliance monitoring determines whether specified criteria are being met as a direct result of an implemented action. The criteria can be numeric or descriptive, but result from the direct impact of the action, not the indirect impact of the action. With the fencing example, the compliance monitoring indicator would be an assessment of the project's basic intent – preventing livestock from entering the riparian corridor – and thus an appropriate metric would be the presence or absence of livestock in the fenced-off area.

Cause-and-effect monitoring

Effectiveness Monitoring – Effectiveness monitoring evaluates whether the management actions achieved their direct effect or goal. Success may be measured against "reference areas," "baseline conditions," or "desired future conditions." Effectiveness monitoring can be implemented at the scale of single actions, suites of actions across space, or for an entire strategy consisting of a diversity of actions in a single place. In the fencing example, the effectiveness monitoring indicators would be an assessment of the project's effect on the riparian habitat, given that the project was properly implemented and in compliance with expected impact. Thus an appropriate metric would be riparian vegetation recovery, since this is expected to be an effect of excluding livestock from the riparian corridor.

***Validation Monitoring* –** Validation monitoring is research to verify the basic assumptions behind effectiveness monitoring and models. Validation monitoring is used to assess the assumed linkage between compliance and effectiveness monitoring indicators, and the assumed linkages between the effectiveness monitoring and the management objectives. In the fencing example, the validation monitoring indicators would be an assessment of two things: first that livestock exclusion results in riparian vegetation recovery so that the latter can be used as a cause-and-effect metric for the former; and second that riparian vegetation recovery results in water temperature reduction and sediment-delivery reduction, the ultimate indirect intent of the initial management action implementation.

1.2 Adaptive Management Definitions

1.2.1 Adaptive Management (LCFRB 2004)

LCFRB (2004) "**Working hypotheses** provide a sound basis for identifying and scaling a suite of appropriate recovery actions but substantial refinements in the scope and focus of measures will be needed as the recovery effort unfolds. Some measures may not produce the desired effects. Other measures will exceed expectations. Unexpected events will occur. A robust and adaptive monitoring, research, and evaluation framework will be critical for weighing progress toward recovery and making appropriate course adjustments along the way."

"**This plan provides the framework for a systematic regional approach**. It generally identifies what needs to be done and how to do it. It does not drill down into specific implementation details such as desired confidence levels, statistical power, data collection protocols, sample sizes, etc. These details will depend on additional refinements to the monitoring, research, and evaluation elements of this plan that will be developed as implementation planning proceeds. Refinements will be predicated on the availability of resources for conducting an integrated monitoring, research, and evaluation program."

The term "adaptive management" is in wide usage among subbasin planners and has come to denote two very different processes. A broad definition involves course correction during plan implementation based on observed progress and refinements in approach or objectives. An alternative definition involves a specific approach whereby substantive actions are implemented in order to invoke a significant response that provides clear direction for tuning. This contrasts with the sequential implementation of small incremental changes intended to steadily move progress toward the objectives. Substantive actions greatly expedite the process for identifying the sufficiency of plan actions but require significant effort by implementing parties. This plan treats adaptive management consistent with both definitions. It identifies substantive improvement increments in productivity consistent with recovery and specific actions intended to make corresponding reductions in threats. It also includes a process for monitoring and refinement as part of plan implementation. The adaptive management process for this plan is based on a series of checkpoints, assessments, benchmarks, and decisions (Figure 3). Checkpoints are formal decision points where substantive changes in direction will be considered. Assessments are formal evaluations of progress and results. Benchmarks are standards or criteria that will drive decisions depending on observed progress in implementation effort and effectiveness. Decisions identify refinements in efforts or new directions based on progress relative benchmarks observed at checkpoints.

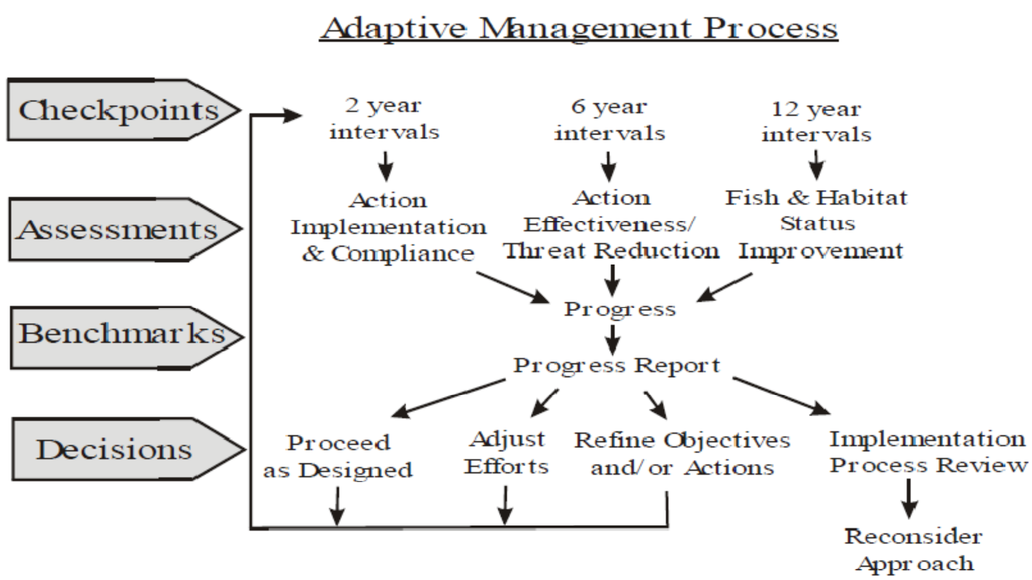


Figure 3. Elements and decision structure for adaptive management process for implementation of Washington lower Columbia River Fish Recovery Plan.

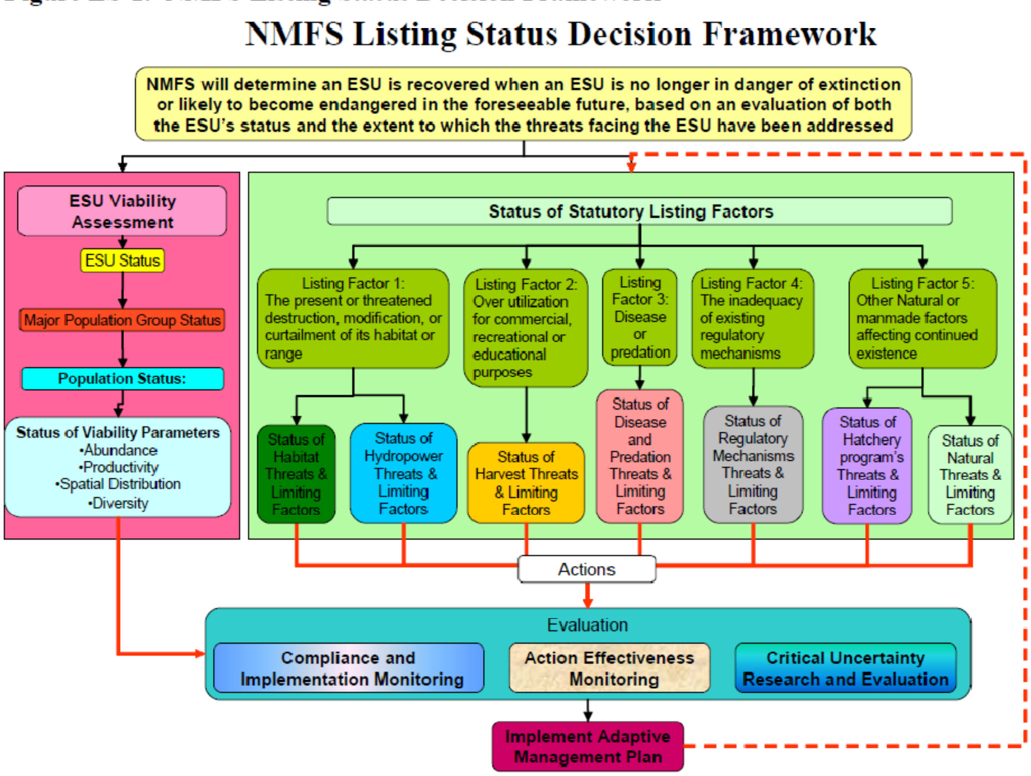
1.2.2 Adaptive Management (NMFS 2007)

NMFS Listing Status Decision Framework

Section 2 presents the NMFS listing status decision framework (decision framework) (Figure ES-1), which illustrates the key questions NMFS will consider in determining ESU status and indicates how the information derived from research, monitoring, and evaluation will be used to answer these questions. The decision framework was developed to help recovery planners design research, monitoring, and evaluation programs that will provide the information NMFS needs for listing and de-listing decisions.

The decision framework is a series of decision-question sets that address the status and change in status of a salmonid ESU, as well as the risks posed by threats to the ESU. The decision-question sets step down from ESU to major population grouping and finally to population scale. The questions at each scale should elicit information needed to make the decision(s) required at that scale.

Figure ES-1. NMFS Listing Status Decision Framework



NMFS ultimately bases a decision to de-list an ESU on a determination that it is no longer in danger of extinction or likely to become endangered in the foreseeable future. This determination must be based on an evaluation of both the ESU's status and the vi extent to which the threats facing the ESU have been addressed. The decision framework is designed to elicit the information needed to meet the statutory and regulatory requirements for de-listing (50 CFR § 424.11).

Adaptive Management

Section 3 provides a conceptual overview of adaptive management. Adaptive management is the process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation, and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends are proposed, prioritized, and implemented when necessary.

An adaptive management plan must include the following elements (Anderson, 2003):
• Management strategies that are revisited regularly;
• The use of conceptual or quantitative models of the system being managed to develop and test hypotheses and to guide strategy and action planning;
• A range of potential management actions that could be used to meet the strategy; • Monitoring and evaluation to track progress;
• Mechanisms for incorporating learning from monitoring and evaluation into decisions on actions and strategies; and
• A collaborative structure for stakeholder participation in adjusting management strategies and actions.

Adaptive management is crucial for salmonid recovery programs because of the length and complexity of the salmonid life cycle and the uncertainties involved in improving salmonid survival and status. The key is to build explicit links between management actions, monitoring data, and biological and physical responses. Several types of monitoring are needed to support adaptive management:
• Implementation and compliance monitoring, used to evaluate whether the recovery plan is being implemented.
• Status and trend monitoring, which assesses changes in the status of an ESU and its component populations, and changes in status or significance of the threats to the ESU.
• Effectiveness monitoring, which tests hypotheses on cause-and-effect relationships and determines (via research) if an action is effective and should be continued.

It is also important to explicitly address the many unknowns in salmon recovery – the "critical uncertainties" that make management decisions much harder. Critical uncertainty research may seem expensive or unnecessary in light of basic information needs; however, in the long run, it will reduce monitoring and implementation costs.

Monitoring and Evaluation for Adaptive Management Sections 4, 5, and 6 discuss monitoring and evaluation for adaptive management in more detail. Section 4 describes guiding principles for the development of two types of monitoring: *status and trends monitoring* and *effectiveness monitoring*. While status and trends monitoring can produce data on population status and on the status of the potentially limiting factors, without some modeling (quantitative, qualitative, heuristic), supported by effectiveness monitoring data, it is impossible to translate between these two data sets or types, i.e. to make cause-and-effect statements. It is essential to build effectiveness monitoring into the implementation plan at the outset, because it requires explicitly coupling the monitoring design and implementation with the action design and implementation in order to detect an effect. *Recovery plan implementation should consist of action strategies that include the demonstration of effect.*

Section 5 discusses, at a conceptual level, the issues related to prioritizing monitoring in the face of resource constraints. Although Sections 2 through 4 lay out the full scope of information that would be desirable to assess the status of salmon and steelhead, the reality is that monitoring programs are developed in a world of finite resources. Local conditions may raise specific questions about how to develop a monitoring program consistent with this guidance. Many of these questions will need to be answered on a case-by-case basis. The design of monitoring programs should begin with the data needs of management and policy decision making; these processes will determine the effort required. Management questions or decisions should also be used to determine spatial, temporal, and precision scales for all monitoring data collection. Critical uncertainties in recovery planning – the current suite of unanswered questions – can also motivate monitoring, though not by way of defining sampling effort. There is real and necessary value to data collection programs that address the critical uncertainties confounding our ability to make effective management decisions. This research-based monitoring is also driven by management questions, in a less direct, but equally important, manner. This section presents some basic design principles to guide the development of efficient and effective monitoring programs; the list is neither exhaustive nor complete, but provides some general rules and thinking for practical monitoring program design.

Section 6 illustrates how monitoring program design can affect the level of certainty that can be attained in evaluating ESU status. Decisions often must be made with incomplete information. Three hypothetical examples show how ESU-scale, ESA status assessments may play out under a range of data and information quality and quantity. Different types of incomplete information pose corresponding types of risks for de-listing decisions. The scenarios described are meant to help planners consider how their implementation and monitoring decisions may affect NMFS' assessment of ESU status, and how to balance monitoring investments.

As local recovery planners begin to design monitoring programs for salmon recovery, they will need to address the issues that are discussed conceptually throughout this document, including:

7) Clarifying the questions that need to be answered for management decision making. • Identifying which populations and associated limiting factors to monitor.
8) Addressing questions of metrics and indicators – frequency, distribution, and intensity of monitoring – and the tradeoffs and consequences of these choices.
9) Assessing the degree to which existing monitoring programs are consistent with this guidance document and identifying needed adjustments in those programs as well as additional monitoring needs and a strategy for filling them.
10) Developing a data management plan (see Appendix B).
11) Prioritizing research needs to address critical uncertainties, test assumptions, and provide other information to support decision making.

This guidance document is meant to help local planners as they frame and evaluate these questions. Again, the guidance is conceptual and does not provide specific answers to specific questions. To anticipate the range and scope of all questions that might arise as planners consider this guidance would have been impossible because of the range of local conditions and the complexities of designing monitoring programs for species as complicated as salmon. NMFS expects to work closely with recovery plan developers to contribute to the process of developing, proposing, prioritizing, and assessing alternative strategies for inclusion in adaptive management plans and recovery plan implementation.

Figure 2 depicts the overall conceptual framework for the evaluation cycle at the center of all management plan implementation. Most salmon management plans are structured in the short term to answer the question in Stage A ("What are you trying to achieve?"), including discussions of the goals and objectives, threats limiting attainment of the goals, and a strategy to achieve the goals. To develop an adaptive management plan, however, it is necessary to move beyond Stage A and thoroughly address the additional, key questions (Stages B-D): How will 22 you know you're making progress? How will you get the information you need? How will you use the information in decision making?

A monitoring and evaluation plan to support adaptive management provides: (1) a clear statement of the metrics and indicators by which progress toward achieving goals can be tracked; (2) a plan for tracking such metrics and indicators; and (3) a decision framework through which new information from monitoring and evaluation can be used to adjust strategies or actions aimed at achieving the plan's goals. Once the plan is designed, it should guide implementation of salmon recovery activities through iterative adjustments in strategies and actions as information from monitoring and evaluation comes forth. Having an adaptive management plan in place at the outset of plan implementation provides greater assurances that the plan will succeed in achieving its objectives. Through the adaptive management plan, strategies and actions needed for salmon recovery can evolve as uncertainties in the effectiveness of actions are reduced through monitoring and evaluation.

An adaptive management plan can offer sufficient assurances in technical results over time because it is a strategy to explicitly address and manage the risk associated with implementing an extremely complex program. Alternatives to adaptive management are more risky in the longterm— getting it right the first time and staying lucky; being wrong and staying wrong; and just muddling through—all might work, but at what cost if they don’t? Less rigorous forms of adaptive management, such as learning from experience, after-the-fact assessment, and flexible planning, also might appear to moderate the risk in the long term. In the short term they lack the explicit feedback through an identified decision-making process that will accelerate response time and form the basis for trusting that a program is working toward its intended objectives. Monitoring and evaluation feeds into adaptive-management-driven decision making through a simple logical chain. Such a chain begins with a problem statement. That statement must address the condition that requires monitoring, as well as the people who must evaluate the monitoring data and make decisions concerning the problem. To connect monitoring data to the decision process, the adaptive management plan must identify types of information needed to make decisions, and trigger points around which decisions are made. Given the inputs to a decision, it is then possible to specify a set of decision rules. Decision rules must specify the spatial and temporal characteristics and the precision of input information for the trigger points. When fully specified, decision rules define the necessary and sufficient monitoring data and information. Finally, with the required information fully specified, a monitoring program can be designed. In an ideal situation the above process would be accomplished in a single pass in advance of recovery plan implementation. However, given the inherent complexity of the recovery plan implementation process, it is likely that the specification of decision information, inputs, and rules will be iterative.

The Evaluation Cycle (Yaffee et al. 2004)

Stage A: What are you trying to achieve? – Creating a situation map
What are your goals and objectives?
What threats and assets affect your project?
What strategies are needed to achieve objectives?
What are the relationships among your objectives, threats and assets, and strategies?
What process issues and concerns affect your project?

In this stage, develop a clear picture of the project's situation and define project success on multiple levels by addressing:
What are the ecological, social and economic *goals and objectives* of the project? What is the target to achieve or change?
What are the *threats and assets* affecting the project? What is preventing progress and what is moving the project forward?
What are the *strategies and activities* of the project? What are our on-the-ground approaches and how are we implementing them?
How do the strategies minimize threats and/or capitalize on assets to move us closer to the goals and objectives? That is, what is the *connected story* behind the activities and objectives within a complex system?
What *organizational process issues*, such as leadership or communication, affect our project's progress?

Stage B: How will you know you are making progress? – Developing an Assessment Framework
What do you want to know?
What do you need to know?
What will you measure to answer your evaluation questions?
How might you use the information?

In this stage, the situation map created in Stage A is used to establish a framework for measuring progress on multiple levels by answering:
What do we want to know? That is, what *evaluation questions* do we want to ask about the impact, implementation, or approach of our project or about the situation in which we work?
What do we need to know? What are our *evaluation priorities*?
What *indicators* will we measure and what will we *compare* these measure against to answer our questions and assess progress?
How might you *use this information* to affect decision making or communicate with stakeholders?

Stage C: How will you get the information you need? – Preparing an Information Workplan
Does available information suit your needs, and if not, how will you collect it?
What are your analysis needs?
How will the necessary activities be accomplished?

In this stage, prepare for the logistics of undertaking the evaluation plan. This includes thinking about:
Where will *data* come from? Is it already available or will it need to be collected, and if so, how?
How will we need to *process or analyze* the data to give us a clear answer to our evaluation question?
Who will be responsible for these activities?

Stage D: How will you use the information in decision making? – Creating an Action Plan
What are your trigger points?
What actions will be taken in response to reaching a trigger point?
Who will respond?
How will you summarize and present your findings?

In this stage, consider ways to tie the evaluation back to decision making by answering:
What will be the *trigger points*? At what level, amounts or rate of change of an indicator will we change course or reconsider our strategies?
What possible *actions* might we take if a trigger point is reached?

Figure 2. Adaptive Management: The Evaluation Cycle (Yaffe et al., 2004)

1.3 Excerpts from "Salmonid ESU Population Categorization" by Peter Hahn and Peter McHugh (2009); WDFW-Fish Program/Science Division/Stock Assessment Unit. (Source: A Review for the 21st Century Salmon and Steelhead Project, August 11, 2008 Review Draft 1).

The 21st Century Salmon and Steelhead Project uses several terms for categorizing populations in terms of their importance to salmon recovery: **Primary**, **Contributing**, and **Healthy and Harvestable** (also "**Core**" but see p. 5-6 below). Other ESA-related documents (i.e., Technical Recovery Team (TRT) viability criteria and population identification reports, regional or ESU-level recovery plans, and resource management plans) have used these and other terms (**Genetic Legacy**, **Sustaining**, **Stabilizing**, **Maintained**, **Independent**, **Viable**, and **Highly Viable**) to characterize population viability and/or recovery potential. In other salmon recovery related documents, others (e.g., coastal Oregon coho and Central California Coast TRTs) have identified populations as **Functionally Independent**, **Potentially Independent**, and **Dependent**. Given the relevance of these documents to the goals and objectives of 21CSS and the potential for confusion over population designations, we sought to: (a) more explicitly define the source and intent of the population designations used by 21CSS, and (b) distinguish them from or bridge them to TRT and/or recovery plan definitions.

An Evolutionarily Significant Unit (ESU) for a particular species is composed of one to many extant and possibly extinct populations (Waples 1991). These populations can be clustered into one or more Major Population Group(s) (MPG; equivalent to strata [Willamette/Lower Columbia recovery domain] or geographic regions [Puget Sound recovery domain]). Various genetic, life history, and spatial distribution characteristics have been used to define an ESU and the populations within it. For most listed ESUs in Washington, TRTs have identified populations (and MPGs) and established viability criteria and/or set standards for Viable Salmonid Populations (VSPs) that provide guidance for delisting from the ESA (Ruckelshaus et al. 2002 [PSTRT], McElhany et al. 2003, 2006 [LCTRT], Anonymous-ICTRT 2004, 2005, and 2007). Each TRT took a slightly different approach that led to slightly different definitions and terminology (see our tabular summary of VSP criteria and S. Busch et al. [unreleased draft]). Further, WDFW and other agencies, tribes, and local stakeholders are concerned with "Healthy and Harvestable" criteria, a population-status designation that looks beyond delisting (i.e., recovery to levels that exceed delisting criteria under the ESA).

To fully understand the population designations that we review in the following pages, it is important to make a distinction between designations that are purely biological or technical in nature and those guided by policy decisions. The former are based on TRT recommendations whereas the latter fall into the domain of recovery planners and stakeholder groups (e.g., Salmon Recovery Boards [SRBs]). Given that TRT-viability standards allow for some flexibility in setting recovery priorities within a particular ESU, these designations—though overlapping—are not necessarily synonymous.

PRIMARY Population

In the 21CSS framework document, a “**primary”** population is defined as:

> “A population that ***must have*** the abundance, productivity, spatial structure and diversity necessary to provide at least a 95% probability of persistence over a 100-year time frame.”

Implied is that such a population is also considered necessary for MPG (aka stratum or geographic region), and therefore ESU, recovery. The quantitative portion of this definition (95% persistence probability over a 100-year time frame) is a feature common to the viability criteria that have been established by TRTs for ESA-listed salmon in Washington, where they exist (i.e., excluding steelhead).

Some other documents that describe primary populations are:

The Lower Columbia Fish Recovery Board (Anonymous-LCFRB 2004 p. 5-7):

“Primary populations are those that would be restored to high or “high+” viability. At least two populations per strata must be at high or better viability to meet recommended TRT criteria. Primary populations typically, but not always, include those of high significance and medium viability. In several instances, populations with low or very low current viability were designated as primary populations in order to achieve viable strata and ESU conditions. In addition, where factors suggest that a greater than high viability level can be achieved, populations have been designated as High+. High+ indicates that the population is targeted to reach a viability level between High and Very High levels as defined by the TRT.”

The FORUM framework document (Crawford [ed.] 2007):

“Primary populations are those that must demonstrate low risk of extinction in order to recover the MPG and ESU. The FORUM has developed this statewide Framework that identifies a set of the most important populations, including at least one from each MPG, for monitoring. In total, the salmon framework identifies a cumulative total of 28 major population groups containing a total of 86 primary populations for chinook, coho, chum, and steelhead.”

The Hatchery Scientific Review Group Columbia Basin Review (Anonymous-HSRG 2008c):

> “…populations of the highest biological significance…”

The Governor’s Salmon Recovery Office’s “2006 State of Salmon in Watersheds” report (Drivdahl (ed.) 2006):

"Primary Fish Population: As identified in a recovery plan, this is a fish population that must achieve a low risk of extinction (i.e., a low risk of not meeting viability criteria)."

Comments and Notes: From these examples, it is clear that a "**primary population"** designation implies that such a population is essential to recovery (and/or delisting). However, it is also clear that the designation of "primary" may not be made strictly for biological reasons (i.e., a determination made by recovery boards in the context of recovery plans and **not** a TRT-viability mandate). In particular, while TRT viability criteria require that 1-2 populations per MPG be recovered to "high" or "high+" levels, there are cases where MPGs are composed of 3+ populations of similar biological significance. This has been confirmed through the HSRG's process where, for instance, primary populations have been re-classified as "**contributing**" populations given the difficulties of fully achieving hatchery reform in a particular basin (i.e., the reform objectives were untenable given the more stringent requirements for primary populations).

Conclusion: The intent of this category is to classify populations that are important within an ESU (i.e., due to their size/intrinsic potential, their possession of unique life-history traits, or their genetic integrity) and for which it is deemed possible to achieve maintenance of, or recovery to, not only a highly viable (high or high+ in WLCTRT terminology) but also *potentially* a "healthy and harvestable" status.

Relevance to 21CSS progress: Relating to this population designation, 21CSS tasks are to (a) identify the primary populations for all ESA-listed ESUs (21CSS Benchmark 2), and (b) identify the VSP goals for all listed primary populations (21CSS Benchmark 3). Task (a) has been preliminarily completed (draft document under review) and work for task (b) is in progress.

CONTRIBUTING Population

In the 21CSS timeline document, "**contributing**" populations were defined as:

> "Populations for which some restoration will be needed to achieve a stratum-wide average of medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery." (verbatim wording from: Anonymous-LCFRB 2004 p. 7)

In place of "stratum-wide" one could substitute "Geographic Region" (used in Puget Sound Recovery Domain) or "Major Population Grouping" (used in Interior Columbia Recovery Domain, although it is unclear how this status level explicitly compares to those defined by the ICTRT.)

As used in documents from the Governor's Salmon Recovery Office (GSRO 2006) **contributing** populations include:

> "…those that will contribute to ESU/DPS viability or play a stabilizing or supportive role…"

Comments and Notes: This "contributing" class of populations includes those that can only be recovered to some level of less than full viability (i.e., to be persistent and abundant enough to satisfy their minimum role in "ecosystem function"). In particular, they are populations that have value at the ESU level but have a lower priority than others given their present state and maximum potential contribution (e.g., Salmon Creek in Vancouver). Improvement is possible and economically or socially feasible, but not to the "high+" viability level. In LCFRB parlance, "Contributing" populations are a rung above "Stabilizing" populations and a rung below "Primary" populations in the recovery prioritization hierarchy. The GSRO's population prioritization list, however, uses only the "Primary" and "Contributing" categorization levels.

HEALTHY AND HARVESTABLE criteria/goal

The 21CSS timeline document stated that a "**Healthy and Harvestable"** (**H&H**) population is:

"A population with sufficient abundance, productivity, diversity and spatial structure to be resilient through environmental fluctuations, to perform natural ecological functions in freshwater and marine systems, provide related cultural values to society, and sustain directed fisheries." (taken from 21CSS WDFW Framework, Dec. 2007 draft)

The Washington State Steelhead Management Plan (Anonymous 2008 p. 34) describes an **H&H** population as:

"A self-sustaining naturally produced stock that has attained a status that will support meaningful retention and non-retention fisheries on an annual basis."

This same document (p. 35) describes a "**Healthy Stock**" as:

"A wild stock that has sufficient viable salmonid parameters (VSP): abundance, productivity, diversity and spatial structure to be resilient through environmental fluctuations, to perform natural ecological functions in freshwater and marine systems, provide related cultural values to society, and sustain tribal and recreational fisheries."

The Lower Columbia Salmon and Steelhead Recovery and Fish & Wildlife Subbasin Plan (Anonymous-LCFRB 2004 p. 5-41) states that:

"Harvestable species, ESUs and populations occur when adult production exceeds the population goal and viability level and can be directly harvested at levels that maintain spawning escapement at or above the biological objective."

This term (H&H) reflects a desired status for all populations and can, in theory, be met by any population no matter what its categorization. However, it is unlikely that populations categorized as contributing, sustaining, or maintained would realistically ever attain this status; therefore, we assume that it is an abundance level (criterion) to be defined for "primary" populations only.

Comments and notes from the 21CSS document provide some additional thoughts:

> *"Healthy and harvestable criteria have been defined for populations in only 6 ESUs (Puget Sound Chinook, Hood Canal Summer Chum, Lower Columbia ESA-listed ESUs and DPSs). In ESA-listed ESUs or DPSs, no populations have abundance, productivity, spatial structure, and diversity that meet or exceed healthy and harvestable levels. In non-listed ESUs, the status of populations relative to the healthy and harvestable definition has not been determined."*

Comments: From these definitions, "healthy and harvestable" simply implies that a population is both viable (according to TRT criteria) and abundant enough to support some ("meaningful") degree of fishery-related mortality. The term "**Core**" population was included as a possible analog of "Healthy and Harvestable" in the 21CSS timeline document, however we believe that "Core" has a rather distinctly different meaning (see below, and refer to McElhany et al. 2006). Therefore, we recommend the use of "Healthy and Harvestable" alone to provide a target toward which we recover and manage stocks. .

Other Population Categorization Terms:

STABILIZING or SUSTAINING or MAINTAINED Populations

In the Lower Columbia Salmon and Steelhead Recovery and Fish & Wildlife Subbasin Plan (Anonymous-LCFRB 2004 p. 5-7):

> **"Stabilizing populations** are those that would be maintained at current levels (likely to be low viability). Stabilizing populations might include those where significance is low, feasibility is low, and uncertainty is high."

The ICTRT (ICTRT 2007 p. 10) used the term "**maintained**" and included some of the concepts for "contributing". A maintained population is less than viable but still provides ecological function, is not a demographic sink for the MPG, preserves genetic and life history characteristics of the MPG, and provides connectivity within or between MPGs. A population can be categorized as "**maintained"** if its abundance and productivity risk level is less than 5% but spatial structure and diversity is high risk, or if its abundance and productivity risk level is between 6-25% with a spatial structure and diversity risk level of moderate, low, or very low (ICTRT 2007).

CORE Populations

This term is used to categorize a population by its historical abundance and productivity, and is not related to its current status. McElhany et al. (2006 p. 10) states:

> "Within a stratum, the populations restored/maintained at viable status or above should be selected to: a. Allow for normative metapopulation processes, including the viability of ***"core" populations****, which are defined as the historically most productive populations*." [our emphasis]

Earlier, McElhany et al. (2003 p. B-1) elaborated:

> "***Historically***, each evolutionarily significant unit (ESU) was characterized by a number of populations that represented the ***substantial portion of the ESU's abundance or contained life history strategies that were specific to the ESU***. These ***core populations*** are important components to maintaining the evolutionary legacy of the ESU. The Willamette Lower Columbia Technical Recovery Team (WLC-TRT) concluded that recovery agencies consider giving priority to these core populations in developing their recovery plans. In addition to sustaining the evolutionary legacy of the ESU, these core populations may offer the most likely path to recovery. If ***these populations sustained large populations historically***, they may have the intrinsic capacity to sustain large populations into the future."

In this McElhany et al. (2003 Appendix B) report, all core as well as legacy populations are listed for the lower Columbia-Willamette ESUs. There has been no term used to designate "**Non-CORE**" populations, but all populations that are not "Core" are by default in this category.

(GENETIC) LEGACY Population

In McElhany et al. (2003 p. B-1), this description was offered:

> "Populations are considered ***genetic legacies*** for two reasons. The population may have had minimal influence from nonendemic fish due to artificial propagation activities, or the population may exhibit important life-history characteristics that are no longer found throughout much of their historical range in the ESU. Populations that are determined to be **genetic legacies** should be considered for prioritization in recovery efforts because they retain the most intact representatives of the genetic character of the ESU. Furthermore, populations that have maintained their genetic integrity should have retained a high degree of adaptation to local watershed

> conditions and are therefore more likely to achieve viable salmonid population (VSP) sustainability than are newly introduced or domesticated populations."

McElhany et al. (2006 p. 11) states:

> "The 2003 viability report provides a list of populations considered "core" and ***"legacy,"*** but provides no quantitative guidelines for this second criterion. The 2003 report relies on case-by-case consideration of proposed strata-level scenarios and we support continuing that approach."

These populations contain some unique genetic and/or life history traits within the ESU. Implied in McElhany et al. (2003) was that these unique traits would qualify a population to be "core", however on pages B-2 and B-4 two populations are listed as legacy but not as "core" (Salmon Creek/Lewis River fall run Chinook, East Fork Lewis River summer steelhead).

VIABLE Populations

McElhany et al. (2000 p. xiii and 2) stated:

"We define a **viable** salmonid population as an independent population of any Pacific salmonid (genus Oncorhynchus) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year time frame."

and:

> "A **viable** salmonid population (VSP)[2] is an **independent** population of any Pacific salmonid (genus Oncorhynchus) that has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame. Other processes contributing to extinction risk (catastrophes and large-scale environmental variation) are also important considerations, but by their nature they need to be assessed at the larger temporal and spatial scales represented by ESUs or other entire collections of populations. ([2]Note: that some early drafts of this document used the term "**properly functioning population**" or "PFP" in place of VSP.)"

*The concept of a **"highly viable"** population is analogous to the ICTRT requirement that one population within each Major Population Group (MPG) meet "highly viable" status. **Highly viable** is defined as less than 1% extinction risk on the viability curve for abundance and productivity and low or very low risk for spatial structure and diversity (ICTRT 2007 p. 77).*

INDEPENDENT Population

The viable salmonid population document (McElhany et al. 2000 p. 5) adopted Ricker's (1972) definition of a stock:

"An independent population is a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season."

The Puget Sound TRT (Ruckelshaus et al. 2006) similarly described an independent population (above). McElhany et al. (2000 page xiii) expanded this definition:

"We define an independent population as any collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period are not substantially altered by exchanges of individuals with other populations. In other words, if one independent population were to go extinct, it would not have much impact on the 100-year extinction risk experienced by other independent populations. Independent populations are likely to be smaller than a whole ESU."

Functionally Independent, Potentially Independent, Dependent populations

We also provide this description of the classification system used by the Oregon coastal coho TRT and the Central California Coast TRT (Lawson et al. 2004 p. xi and 10):

> "We utilized a Relative Independence Model to classify these populations on the basis of two key characteristics: persistence (their relative abilities to persist without input from neighboring populations), and isolation (the relative degree to which they might have been influenced by adult fish from other populations migrating into their spawning areas). The interaction of these two factors across what we believe to have been the historical populations of Oregon Coast coho salmon gives us a measure of Relative Independence. This Relative Independence gives us a basis for classifying the populations as Functionally Independent, Potentially Independent, and Dependent. Nine populations were identified as Functionally Independent, 9 as Potentially Independent, and 48 historical populations were identified as Dependent populations. We will use this classification in the next step - analyzing the viability of populations and ultimately of the ESU in order to identify quantitative goals for recovery. Two other recovery groups (the SONCC Workgroup and the Central California Coast TRT) are also using the Relative Independence Model to classify their populations."

> **"Functionally Independent populations**: high-persistence populations whose dynamics or extinction risk over 100-year time frame is not substantially altered by exchanges of individuals with other populations. These populations are net "donor"

populations that may provide migrants for other types of populations. This category is analogous to the "independent populations" of McElhany et al. (2000)."

"**Potentially Independent populations**: high-persistence populations whose population dynamics may be substantially influenced by periodic immigration from other populations. In the event of the decline or disappearance of migrants from other populations, a Potentially Independent population could become a Functionally Independent population."

"**Dependent populations**: low-persistence populations that rely upon immigration from other populations. Without these inputs, Dependent populations would have a lower likelihood of persisting over 100 years. They are "receiving" populations that are dependent on sufficient immigration from surrounding populations to persist."

1.4 Accountability for Results and Risk: Definitions for Performance Standards, Adaptive Management, Reporting, Oversight, and Contingencies (NOAA Fisheries, Adaptive Management, May 21, 2007).

Accountability for Results:

• **Action Commitments:** The Action Agencies' specific commitments, including funding, presented in the form of a proposed Reasonable and Prudent Alternative (RPA), provide the first means to gauge results.

• **Performance Standards:** Commitments to action are reinforced by performance targets (long term goals) and performance standards (benchmarks for results). These will help us track and gauge the effectiveness of our actions.

• **Planning and Reporting:** A key aspect of our accountability structure is implementation plans, reporting and check-ins. The Action Agencies will report annually on progress of implementation and performance results to inform and signal appropriate adaptations or adjustments to our actions, and provide cumulative check-ins at 5 and 8 years.

• **RM&E and Adaptive Management:** Using a program of extensive and robust research, monitoring and evaluation (RM&E), the Action Agencies will assess compliance, effectiveness, and critical uncertainties. Adaptive management will be used to modify our actions and ensure that they continue to track performance expectations, based on the best available scientific information.

• **Oversight:** Continued collaboration and oversight of implementation by the sovereign parties is provided, including review of how listed fish are progressing toward recovery and "all H" diagnosis of emerging issues.

• **Contingencies:** Consistent with the 2000 Biological Opinion, we provide specific and general contingencies in case more aggressive adaptive management changes are called for based on evaluation of our performance in years 5 and 8.

Performance-Based Framework:

Performance targets: Performance goals for actions. These are generally the survival improvements from the life cycle modeling, and will continue to be assessed using a modeling approach. The performance targets represent long-term goals, which are not necessarily achievable by this PA/BiOp alone.

Performance standards: Results or benchmarks for accountability for FCRPS actions. They may be biological, physical, programmatic or a combination. This PA establishes contingencies to address failure to meet performance standards.

Performance metrics or measures: Units of measurement for assessing performance targets or performance standards.

All-H Reporting metrics: Broad level measurements which the Action Agencies may report but which are not the exclusive performance responsibility of the FCRPS, -e.g. adult trends

Summary of Performance Targets and Standards

The following table provides a summary of performance targets, standards, monitoring and reporting under the performance based framework.

Outline of Performance Tracking and Reporting

Performance Targets	Performance Standards	Monitoring	Reporting
Fish Population Metrics			
Positive Trends in Abundance		Context for prioritization of actions and adaptive management needs	Comprehensive Reports (using BRT Status Report)
Hydro			
% increase in system survival – by ESU		Juvenile Passage RM&E and System Survival Modeling	Comprehensive Reports
	Hydro PA Programmatic Standards	Project Implementation and Compliance Monitoring	Annual Progress and Comprehensive Reports
	Juvenile Dam Survival Standards (95% average for Spring Migrants and 93% average for Summer Migrants)	Juvenile Passage Monitoring and Dam Survival Modeling	Annual Progress and Comprehensive Reports
Flow and temperature targets (adjusted to reflect what annual and seasonal water conditions)	Juvenile and Adult Hydro System Environmental and Physical Configuration Standards	Environmental Monitoring at Mainstem Dams	Annual Progress and Comprehensive Reports
	Adult Hydro System Survival (no significant change from current average survival levels)	Adult System Survival	Annual Progress and Comprehensive Reports
Tributary Habitat			
% function improvement – by population for actions through 2007 and through 2017		Intensively Monitored Watersheds, Status Monitoring, and Project Level Monitoring informs and updates modeling	Comprehensive Reports
	Tributary Habitat PA Programmatic Standards (3 year cycle)	Project Implementation and Compliance Monitoring	Annual Progress and Comprehensive Reports

Estuary Habitat			
% function improvements for Stream Type and Ocean Type ESUs for actions through 2007 and through 2017		Status Monitoring and Project Level Monitoring informs and updates modeling	Comprehensive Reports
	Estuary Habitat PA Programmatic Standards	Project Implementation and Compliance Modeling	Annual Progress and Comprehensive Reports
Hatchery			
Low, Med or High benefits relative to objectives – by target Populating		Status Monitoring and Project Level Monitoring and updates Lifecycle Modeling	Comprehensive Reports
	Hatchery PA Programmatic Standards; site specific BMPs	Project Implementation and Compliance Monitoring	Annual Progress and Comprehensive Reports
Predation			
% survival increase for spring migrants and for summer migrants		Predation action effectiveness research and status monitoring	Comprehensive Reports
		Predator exploitation rates	Comprehensive Reports
	Predation PA Programmatic Standards	Project Implementation and Compliance Monitoring	Annual Progress and Comprehensive Reports

Appendix 2. Research, Monitoring and Evaluation (RM&E) Proposed Action Summary (NOAA Fisheries, RM&E, May 21, 2007).

RM&E Action Objective for All ESUs: Perform RME to address compliance monitoring, effectiveness monitoring, and critical uncertainties research related to the implementation of FCRPS ESA actions.

The following RM&E actions will provide information needed to support adaptive management, demonstrate accountability, and guide hydro and offsite actions to achieve desired biological results. RME will address the following management questions related to FCRPS ESA actions:

- Are actions being implemented as proposed? → Compliance Monitoring
- Are performance standards and targets for each ESA listed ESU and steelhead DPS being achieved? What is the effectiveness of specific types of actions in addressing limiting factors? → Status and Effectiveness Monitoring
- Are there management questions or limiting factors that require further understanding? → Critical Uncertainties

The Action Agencies will undertake RM&E in the following nine areas:
- Fish Population Status
- Hydrosystem
- Tributary Habitat
- Estuary and Ocean
- Harvest
- Hatchery
- Predator
- Coordination and Data Management
- Project Implementation and Compliance Monitoring

RME Strategy 1: Monitor Status of Selected Fish Populations Related to FCRPS Actions

Rationale: Monitoring status of selected populations supports future examination of recovery and survival metrics and trends for all Hs, including actions by the FCRPS and others. **Management Questions:** The primary management questions regarding information on fish populations for the FCRPS are as follows:
- What are the abundance, productivity, and spatial distribution of ESA listed populations affected by the FCRPS?
- What is the proportion of ESA listed populations that are of hatchery origin?

RME Strategy 2: Hydrosystem RM&E

Rationale: Evaluating the effectiveness of hydro actions and critical uncertainties is a central feature of the FCRPS ESA responsibilities.
Management Questions: The following are the primary management questions with respect to FCRPS hydro passage actions. Hydro RM&E actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are salmon and steelhead meeting juvenile and adult hydro passage performance standards and targets?
- Is each project in the hydropower system safely and efficiently passing adult and juvenile migrants?
- What are the most effective configurations and operations for achieving desired performance standards and targets in the FCRPS?
- What is the post-Bonneville mortality effect of changes in fish arrival timing and transportation to below Bonneville?
- Under what conditions does in-river passage provide greater smolt-to-adult return rates than transport?

RME Strategy 3: Tributary Habitat RM&E

Rationale: Evaluating the effectiveness of habitat actions that are being implemented as off site mitigation for dam effects is a central feature of the FCRPS ESA responsibilities.
Management Questions: The following are the primary management questions with respect to tributary habitat offsite mitigation actions. The RM&E actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are tributary habitat actions achieving the expected biological and environmental performance targets?
- What are the relationships between tributary habitat actions and fish survival or productivity increases? What actions are most effective?
- What are the limiting factors or threats preventing the achievement of desired habitat or fish performance objectives?

RME Strategy 4: Estuary Habitat and Ocean

Rationale: Evaluating the effectiveness of habitat actions that are being implemented as off site mitigation for dam effects is a central feature of the FCRPS ESA responsibilities.
Management Questions: The estuary/ocean RME material here draws on the "*Plan for Research, Monitoring and Evaluation of Salmon in the Columbia River Estuary*" (Estuary/Ocean RME Subgroup 2004) and the "*Research, Monitoring and Evaluation –*

Conceptual Framework Outline" (Sovereign Collaboration Group 2006). For the purposes of this document, the estuary/ocean is defined as the tidally-influenced portion of the river and its tributaries from Bonneville Dam to and including the plume and nearshore ocean; lower Columbia River tributary watersheds above tidal influence are not part of the study area. The following are the primary management questions with respect to Estuary Habitat actions. The RM&E actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are aquatic, riparian, and upland estuary habitat actions achieving the expected biological and environmental performance targets?
- Are the offsite habitat actions in the estuary improving juvenile salmonid performance and which actions are most effective at addressing the limiting factors preventing achievement of habitat, fish, or wildlife performance objectives?
- What are the limiting factors or threats in the estuary/ocean preventing the achievement of desired habitat or fish performance objectives?

RME Strategy 5: Harvest RM&E

Rationale: Evaluating improved harvest actions that would allow more natural fish to spawning grounds is a feature of the FCRPS action.
Management Questions: Key management questions related to FCRPS-sponsored harvest improvements are:

- What is the effect of acquiring more accurate and precise inriver harvest estimates on the resultant estimates of straying and adult passage survival?
- Can selective fisheries targeting hatchery fish or healthy populations reduce impacts on ESA listed populations?

RME Strategy 6: Hatchery RM&E

Rationale: Hatcheries provide central mitigation for FCRPS effects. Safety net and conservation hatcheries and hatchery reforms funded by the Action Agencies should be evaluated within the framework of ESA recovery goals.
Management Questions: The following are the primary management questions with respect to hatchery actions. Hatchery RM&E actions are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are hatchery improvement programs and actions achieving the expected biological performance targets?
- What is the proportion and origin of hatchery fish within naturally spawning salmon and steelhead populations?
- Can hatchery reforms reduce the deleterious effects of artificial production on listed populations, thereby contributing to a reduction in extinction risk for affected natural populations?

• Can properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations?
• What is the reproductive success of hatchery fish spawning in the wild relative to the reproductive success of wild fish?

RME Strategy 7: Predator RM&E

Rationale: Evaluating predator management actions is a key aspect of the FCRPS actions.
Management Questions: The following are the primary management questions with respect to predation. Predation RM&E actions described in this plan are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.
• Are predator programs and actions achieving the expected biological performance targets? • What are the impacts and consumption rates of major piscivorous, avian, and mammalian predators on juvenile salmonids within the Columbia River Basin?
• What are the distributions, population sizes, and productivity for the major predators within the Columbia River Basin?
• Is there compensation occurring in reaction to predator reduction measures?
• What is the effect of alternative management alternatives/actions used to reduce the impact of predators? What are the most effective management alternatives/actions?

RME Strategy 8: RM&E Coordination and Data Management

Rationale: Because FCRPS RME is part of the overall RME for recovery of salmon in the Columbia Basin, coordination and data management are tools to make this RME more effective

RME Strategy 9: Project Implementation and Compliance Monitoring

Rationale: Regular tracking of implementation commitments is essential to accountability.
The Action Agencies have identified specific commitments or actions for each of our hydrosystem, estuary/ocean, tributary habitat, hatchery, and predator control strategies, providing clear programmatic level measures for evaluating progress, subject of course to adaptive management. We will update these implementation details in 3 year cycles. Projects will be monitored for implementation of planned deliverables and compliance to performance expectations.

Appendix 3. NOAA Fisheries Service Guidance For Monitoring Recovery of Salmon and Steelhead Listed Under the Federal Endangered Species Act (Idaho, Oregon, and Washington). Draft – April 27, 2009 (Crawford and Rumsey 2009).

EXECUTIVE SUMMARY

This guidance document is designed to better assist those involved with salmon recovery in understanding the recovery monitoring needs and the associated level of certainty at the regional, local, and project level. The recommendations included are for federal and state agencies, Indian tribes, local governments and watershed organizations participating within each evolutionarily significant unit (ESU) and distinct population segment (DPS) which are actively developing recovery plan monitoring programs, or are modifying existing monitoring. It is our intention that these recommendations will be considered as the desired level of monitoring to be conducted and will provide a consistency across ESU domains. Recommendations include monitoring that addresses all of the viable salmonid population (VSP) criteria and the listing factors and threats. Following are specific NOAA Fisheries Service recommendations for monitoring, data collection, and reporting ESA information. This document is not intended as a step by step process to de-list a species.

RECOMMENDATIONS FOR DATA COLLECTION EVALUATION AND REPORTING

1. The regional environmental databases should be coordinated such that a common set of metadata and common data dictionaries are used to track information so that it can be readily reported to NOAA Fisheries Service and shared among the participants (page 19).

2. The natural resource agencies and tribes should develop automated internal infrastructure to assess and evaluate their data such that all methods and calculations are transparent and repeatable to all interested parties (page 20).

3. All recovery entities should include elements of the Pacific Coast Salmon Recovery Fund (PCSRF) database dictionary for tracking implemented projects within their databases and or/ adequate data mapping of projects to be able to provide data to the PCSRF database when NOAA is conducting a status review (page 21).

4. The regional salmon recovery partners should build a distributed data system that can communicate between various agencies and tribes involved in natural resources and report to the public progress in salmon recovery (page23).

5. The agencies and tribes sampling habitat, water quality, and fish VSP criteria should coordinate their sampling programs to fit within an integrated master sample program for the domain or tri-state region (page 25).

RECOMMENDATIONS FOR MONITORING VSP STATUS/TRENDS

VSP Adult Spawner Abundance

6. Incorporate a robust unbiased adult spawner abundance sampling design that has known precision and accuracy. (page37).

7. Monitor ratio of marked hatchery salmon and steelhead with an external adipose clip to unmarked natural origin fish in all adult spawner surveys (page 38).

8. Agencies and tribes, as a first step to improved data quality, should calculate the average coefficient of variation for all adult natural origin spawner databases for ESA populations and provide that information to all interested parties (page 39).

9. Agencies and tribes should strive to have adult spawner data with a coefficient of variation (CV) on average of 15% or less for all ESA populations (page 39).

10. Agencies and tribes should conduct a power analysis for each natural population monitored within an ESU to determine the power of the data to detect a significant change in abundance and to provide that information to all interested parties (page 40).

11. Agencies and tribes should utilize the protocols published in the American Fisheries Society Salmonid Field Protocols Handbook whenever possible in order to standardize methodologies across the region in evaluating population abundance (page40).

VSP Productivity

12. Agencies and tribes should develop at least 12 brood years of accurate spawner information as derived from cohort analysis in order that NOAA Fisheries can use the geometric mean of recruits per spawner to develop strong productivity estimates (page 431).

13. Agencies and tribes should obtain estimates of juvenile migrants for at least one significant population for each major population group (MPG) within an ESU or distinct population segment (DPS) (page 44).

a. The goal for all populations monitored for juvenile migrant is to have salmon data with a CV on average of 15% or less and steelhead data with a CV on average of 30% or less. (page44).

b. A power analysis for each juvenile migrant population being monitored within an ESU should be conducted to determine the power of the data to detect a significant change in abundance and to provide that information to all interested parties.

VSP Spatial Distribution

14. Determine spatial distribution of listed Chinook, coho, and steelhead with the ability to detect a change in distribution of ± 15% with 80% certainty. (Page 47).

VSP Species Diversity

15. As a short term strategy, utilize species distribution information and spawn timing, age distribution, fecundity, and sex ratios to determine status/trend in species diversity of natural populations (page 49).

16. As a long term strategy, develop a baseline of DNA microsatellite markers based on single nucleotide polymorphism (SNPs), allozyme and DNA genotypes and phenotypes for each population within each MPG and ESU (page 49).

RECOMMENDATIONS FOR MONITORING LISTING FACTORS AND THREATS

Threats Due To Loss of Habitat

17. Implement a randomized geospatially referenced tessellated habitat status/trend monitoring program incorporating on the ground protocols coupled with remote sensing of land use and land cover. Coordinate and correlate habitat status/trend monitoring with fish in and fish out monitoring wherever possible (page 52).

18. USEPA, state agencies, and local governments should monitor storm water and cropland runoff for status/trends of concentrations of toxics and identify their sources (page 55).

19. To the extent possible all regional and local restoration efforts should be capable of being reported and correlated with habitat limiting factors as defined in the PCSRF data dictionary so that the cumulative effects of restoration actions can be tracked and given proper credit by population, MPG, and ESU/DPS (page 55).

20. Reach scale effectiveness monitoring should be conducted for various habitat improvement categories using a Before and After Control Impact (BACI) design whenever possible. Recovery entities should coordinate their monitoring to reduce costs and improve sample size (page 57).

21. Implement at least one intensively monitored watershed (IMW) for each domain and address different limiting factors by coordinating IMW sites and designs across the Pacific Northwest utilizing a BACI design wherever possible (page 58).

22. For maximum ability to detect change and to avoid poorly designed studies that cannot detect change, IMWs should have a power analysis completed early in the project to determine the amount of the watershed required to be treated in order to detect a 30-50% change in fish response (page 59).

Threat Due To Hydropower Production

23. Monitor all hydropower facilities for status/trends of survival impacts to upstream migrating adults and downstream migrating juvenile salmon and steelhead (Page 61).
Threats Due To Overutilization (Harvest)

24. Manage exploitation rates and total catch in coast wide fisheries and terminal fisheries for TRT identified natural populations phasing out the use of all hatchery-natural stock aggregates by 2020 (page 66).

25. Cohort reconstructions for natural populations should be made available to the science community within one year of the return of all age classes in the cohort (page 66).

26. The PNW states and tribes should recalibrate the FRAM model to reflect harvest management of natural populations (page 67).

27. Initiate snapshot sampling programs in the various coastal fisheries to capture the distribution of the TRT population within the specific fisheries in preparation for a coast wide annual coordinated approach to monitoring harvest status/trends by 2020. (page 68).

28. The states and tribes should be able to demonstrate that there was a greater than 90% compliance with adopted fishery regulations designed to minimize incidental take of listed species (page 69).

29. Allowable incidental harvest rates identified for coastwise, in river, and terminal fisheries should be modeled annually to determine their effectiveness in providing for ESU population spawner escapement goals in terms of years to recovery and jeopardy (page 69).

Threats Due to Disease and Predation

30. In order to determine the extent of the threat from aquatic invasive species, the status of existing invasive species should be compiled for each ESU/DPS and watershed assessments for those species known to affect salmon and steelhead should be conducted (page 75).

Threats Due To Inadequacy of Regulatory Actions

31. Implement a recovery plan tracking system that will be capable of recording whether local and state agencies have implemented regulatory actions proposed in recovery plans (page 77).

32. Develop a randomized sampling program to test whether permits issued under local and state regulatory actions designed to protect riparian and instream habitat are in compliance and that the provisions have been enforced. Compliance rate should be equal to or greater than 90% (page 78).

Threats Due To Hatchery Production

33. The states and tribes should be able to determine annually the percent hatchery origin spawners (PHOS) and natural origin spawners (PNOS) for each population changes of ± 5% with 80% certainty and determine the trend toward reaching HGMP targets. (page 82).

34. The proportion of natural influence (PNI) for primary populations within the ESU for supplementation programs should be calculated periodically. (page 82).

35. A Hatchery and Genetic Management Plan (HGMP) must be developed for each hatchery and submitted to NOAA Fisheries Service for approval and to determine whether they are complete (page 84).

36. Documentation should be available that demonstrates that Hatchery and Genetic Management Plans have been implemented and to what extent (page 84).

37. Every hatchery program should monitor and record the practices and protocols it follows and be ready to report this information on an annual basis (page 85).

38. Every hatchery should monitor the spatial and temporal distribution of juvenile fish released from the program (page 85).

39. Implement effectiveness monitoring recommended by the Ad Hoc Supplementation Monitoring and Evaluation Workgroup by developing a large scale treatment/reference design to evaluate long term trends in the abundance and productivity of supplemented populations. This strategy should be incorporated into each ESU and DPS containing

supplementation hatcheries and should be coordinated across broader geographic scales such as the recovery domains, Columbia River and Puget Sound basins (page 85).

40. The genotype and phenotype of every hatchery brood stock program should be monitored periodically to determine effectiveness of maintaining the integrated or isolated stock goals of the hatchery product (page 86).

41. Assess effectiveness of actions taken to address threats to NOF due to hatchery operations (page 88). Threats Due To Natural Causes

42. The states and tribes can assist in monitoring the effects of changes in climate upon salmon and steelhead populations by monitoring changes in stream flow, temperature, and their effects upon freshwater survival at all life stages (page 92)

Appendix 4. Key limiting factors for Columbia River chum (Source NOAA Fisheries 2008; Table 8.9.2.1-2.).

Mainstem Hydro Direct mainstem hydro impacts on the Columbia River chum ESU are most significant for the Upper and Lower Gorge populations. For the Upper Gorge population, some productive historical spawning habitat was inundated by Bonneville pool. FCRPS flow management affects the amount of submerged spawning habitat for the mainstem component of the Lower Gorge population and whether adults can enter (and fry can emerge from) Hardy and Hamilton creeks. Impacts on populations originating in subbasins further downstream (i.e., below the Portland/Vancouver area) are limited to migration and habitat conditions in the lower Columbia River (below Bonneville Dam) including the estuary.

Predation Avian predators are assumed to have minimal effect on chum salmon. The significance of fish predation on juvenile chum is unknown.

Harvest Harvest is limited to indirect fishery mortality. In the 1950s, due to severe population declines, commercial chum salmon fisheries were closed or drastically minimized. Now there are neither recreational nor commercial fisheries in the Columbia River. The number of chum landed as take incidental to the lower river commercial gill net fisheries has been less than 50 fish in each of the last five years.

Hatcheries Historical hatchery practices do not appear to have influenced chum populations. WDFW's conservation hatcheries are currently an element of chum salmon protection and restoration efforts. Along with other state and Federal hatchery programs throughout the lower Columbia River, these are currently the subject of a series of comprehensive reviews for consistency with the protection and recovery of listed salmonids. A variety of beneficial changes to hatchery programs have already been implemented and additional changes are anticipated.

Estuary The estuary is an important habitat for migrating juveniles from Columbia River chum populations. Alterations in attributes of flow and diking have resulted in the loss of emergent marsh, tidal swamp and forested wetlands. These habitats are used extensively by chum juveniles which migrate from their natal areas soon after emergence (Fresh et al. 2005). Estuary limiting factors and recovery actions are addressed in detail as part of a comprehensive regional planning process (NMFS 2006b).

Habitat Widespread development and land use activities have severely degraded stream habitats, water quality, and watershed processes affecting anadromous salmonids in most lower Columbia River subbasins, particularly in the low to moderate elevation habitats most often used by chum. The Washington Lower Columbia Recovery and Subbasin Plan (LCFRB 2004) identifies current habitat values, restoration potential, limiting factors, and habitat protection and restoration priorities for chum by reach in all Washington subbasins. Recovery and subbasin plans also identify a suite of beneficial actions for the protection and restoration of tributary subbasin habitats. Similar information is in development for Oregon subbasins.

Ocean & Climate Analyses of lower Columbia River salmon and steelhead status generally assume that future ocean and climate conditions will approximate the average conditions that prevailed during the recent base period used for status assessments. Recent conditions have been less productive for most Columbia River salmonids than the long-term average. Although climate change will affect the future status the ESU to some extent, future trends, especially during the time period relevant to the Prospective Actions, are unclear. Under the adaptive management implementation approach of the Lower Columbia River Recovery and Subbasin Plan, further reductions in salmon production due to long-term ocean and climate trends will need to be addressed through additional recovery effort (LCFRB 2004).

Appendix 5. Lower Columbia Fish Recovery Board 2009 Habitat Project Application Evaluation Criteria and Questions. (LCFRB Web Site: http://www.lcfrb.gen.wa.us/2008%20HWS.htm)

Appendix 5.1. Lower Columbia Fish Recovery Board 2009 Habitat Project application Evaluation Questions.

I. OVERVIEW
This document describes the criteria that will be used by the Lower Columbia Fish Recovery Board (LCFRB) Technical Advisory Committee (TAC) and staff to evaluate habitat protection and restoration project proposals.

Proposals are evaluated to determine their potential benefits to fish and the likelihood or certainty that they will achieve those benefits.

Benefits to Fish can be generally defined as improvements in productivity, abundance, and/or distribution of a fish population. They are determined based on measures, strategies, actions, and priorities identified in the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB, 2004) and the 6-Year Habitat Work Schedule (LCFRB 2008). The two key components of the Benefits determination are:

a. The importance of the fish populations, key life history stages and associated limiting factors targeted by the project; and
b. The extent to which the project will address the targeted limiting factors. Of equal importance to a project's potential benefits is the likelihood that it will achieve those benefits. Key considerations in evaluating a project's Certainty of Success are:

a. Whether the project scope and approach are technically appropriate;
b. The extent to which the project is coordinated with other habitat protection and restoration efforts in a watershed;
c. Physical (site or watershed conditions), legal, social, or cultural constraints;
d. The qualifications and experience of the sponsor;
e. Community and landowner support; and
f. Adequacy of stewardship and maintenance provisions.

Using this evaluation process, each project is assigned Benefit and Certainty ratings of High, Medium, or Low as well as a numerical score. Each project is then assigned to priority grouping 1 through 4 based on its benefit and certainty ratings using the matrix (Table 1). Finally, projects are ranked within each priority group based on their numerical scores.

Table 1. Project Priority Grouping Matrix

		Certainty		
		High	Medium	Low
Benefit	High	Group 1	Group 2	Group 4
	Medium	Group 2	Group 3	Group 4
	Low	Group 4	Group 4	Group 4

A more detailed discussion of Benefit and Certainty ratings and scoring is provided below.

II. BENEFITS TO FISH
a. Introduction
Benefit to fish ratings and scores are the combination of:

1. A population/reach rating and score;
2. The Protection/Access/Restoration (PAR) Ratings and Scores; and
3. Cost Score

Benefit Ratings are High, Medium, and Low and the maximum Benefit Score is 200 points. It should be noted that in developing a benefit score and rating it is assumed that each proposed project will achieve its goals and predicted outcomes. The likelihood that a project will actually achieve its goals or predicted outcomes is evaluated in determination of the project's Certainty of Success.

In evaluating a project's potential benefit to fish, LCFRB Staff and the TAC will rely heavily on the technical information and the strategies, measures, actions, and priorities contained or referenced in the Recovery Plan and the 6-Year Habitat Work Schedule. Applicants may take exception to this information in their project proposals and provide technical information supporting such an exception. The LCFRB staff and the TAC will consider the technical information or justification provided by the sponsor in evaluating the proposal.

b. Population/Reach Ratings and Score
1. Introduction.
Population/Reach Ratings and Scores reflect the degree to which a project targets priority populations and reaches Identified in the Recovery Plan and 6-Year Habitat Work Schedule.

The Population/Reach Rating uses reach Tier designations set forth in the recovery plan to indicate whether a project is targeting a high priority population(s) and a high priority reach for the population(s). Reach ratings are High, Medium, and Low. The Population/Reach Score is used to further differentiate between projects with the same Population/Reach Rating.

The Population Reach Score is based on the number of populations within the reach or reaches targeted by the project, the population recovery goals, and the importance of the targeted reach or reaches to the productivity and abundance of the populations. The maximum Population/Reach Score is 100 points.

2. Population/Reach Rating
A project's Population/Reach Rating is based on the Tier of the targeted reach or reaches. Tier ratings are based on Population Recovery Goals (Table 2) and the EDT-derived Species Reach Potential and are assigned in the Recovery Plan based on the rules in Table 3.

Table 2. Population Recovery Goals

Population Classification	Viability Goal	Description	Persistence Probability[1]
Primary (P)	High (H) or High+ (H+)	Low (negligible) risk of extinction (represents a "viable" level)	95-99%
Contributing (C)	Medium (M)	Medium risk of extinction	75-94%
Stabilizing (S)	Low (L)	Stable, but relatively high risk of extinction	40-74%

[1]100-year persistence probabilities (LCFRB 2004)

Table 3. Reach Tier Designation Rules

Designation Rule	
Reaches	**Rule**
Tier 1	All high priority reaches (based on EDT) for one or more primary populations.
Tier 2	All reaches not included in Tier 1 and which are medium priority reaches for one or more primary population and/or all high priority reaches for one or more contributing populations.
Tier 3	All reaches not included in Tiers 1 and 2 and which are medium priority reaches for contributing populations and/or high priority reaches for stabilizing populations.
Tier 4	Reaches not included in Tiers 1, 2, and 3 and which are medium priority reaches for stabilizing populations and/or low priority reaches for all populations.

If a project targets a Tier 1 reach or Tier 1 reaches, it receives a "High" rating. If it targets no Tier 1 reach or reaches, but targets one or more Tier 2 reaches, it receives a "Medium" rating. If it targets only Tier 3 or 4 reaches, it received a "Low" rating.

Projects proposed for the Lower Columbia mainstem and estuary and the tidally influenced portions of tributaries may also benefit out-of-basin or upriver populations. In such cases, out-of-basin salmon and steelhead populations are collectively considered a

“Primary” population. No EDT analysis has been conducted for out-basin-populations. In absence of such analyses, targeted reaches with out-of-basin salmon and steelhead populations are considered Tier 2 and given a “Medium” rating.

3. Population/ Reach Score:
In addition to its Population/Reach Rating, each project receives a numerical Population/Reach Score. Reaches differ in their actual or potential value to fish populations. This score reflects those differing reach values within a given Tier. Specifically, reaches within the same Tier may be utilized by a varying number of populations with different recovery goals. In addition, the targeted reach or reaches may differ in importance to the populations. The score is the cumulative total of the Population Classification (Primary = 3, Contributing = 2, Stabilizing =1) plus the Species Reach Potential (High=3, Medium=2, Low=1) for each population using the targeted reach or reaches. The Population Goals (Table 3) and Species Reach Potential ratings were taken from the Recovery Plan and 6-Year Habitat Work Schedule.

As with the population reach rating, the population/reach score for projects targeting out-of-basin salmon and steelhead populations is calculated based on the out-of-basin populations being collectively considered “Primary” populations and the Species Reach Potential as “Medium.”

For multiple reach projects, Population/ Reach Score is the average of the Population/ Reach scores for the individual reaches.

c. The Protection/Access/Restoration (PAR) Ratings and Scores
1. Introduction
The Protection/Access/Restoration (PAR) rating and score reflect whether a project targets priority habitat project needs and the extent to which the project would be anticipated to address those needs. The PAR rating indicates whether a project is targeting a high priority habitat need. PAR ratings are High, Medium, and Low. A project is given an overall PAR rating of High, Medium, or Low based on the rating of the project’s predominate restoration type or, if the project is felt to address several project types to an equal or similar degree, an average of the project type ratings is used.

The PAR Score is an estimate of the extent to which a project addresses the targeted habitat need(s). Based on the project proposal and other information supplied by the sponsor, the anticipated quantity and quality of habitat protected and/or restored are assessed to arrive at the PAR score. A project’s overall PAR score is the sum of its protection, access, and restoration. Protection, access, and restoration scores are normalized so that they carry equal weight. The score range for the overall PAR score is 0 to 85 points. The initial PAR score is developed by LCFRB staff. The LCFRB TAC reviews and may revise the PAR score based on its evaluation of the project.

2. Protection Rating and Score
The protection rating is based on the EDT preservation rating for the targeted reach or reaches using the flowing scale:

Table 4. Protection Rating

EDT Reach Preservation Rating	Protection Rating
>50%	High
25 to 49%	Medium
<25%	Low

Reach EDT preservation ratings are found in the Recovery Plan. The protection score is the product of the EDT preservation rating times the number of habitat units. One habitat unit equals 500 feet of stream length on both sides or 1,000 feet of stream length on one side of the stream.

3. Access Rating and Score

The access rating is based on the quality of the habitat that would be made available and a passage improvement factor. The quality is the average of upstream Tier reach ratings, where Tier 1=4 points, Tier 2=3 points, Tier 3=2 points, and Tier 4=1 points and an average Tier score of 3 or greater is “high”, 2 but less than 3 is “medium”, and less than 2 is “low”. Where no Tier rating is available the quality factor is derived using habitat assessment data provided by the project sponsor. The passage improvement factor is equal to proposed passibility percentage less the current passibility percentage furnished in the project application, where a score of 60 to 100% is “high”, 30 to 59% is “medium” and <30% is “low”. The overall access rating is then derived using the matrix in Table 5.

Table 5. Access Rating Matrix

		Habitat Quality		
		High	Medium	Low
Passage Improvement	High	High	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low

The access score is the product of the passage improvement percentage times the appropriate Habitat Quality and Habitat Quantity Factors selected from Table 6.

Table 6. Access - Habitat Quantity and Quality Factors

Habitat Quantity	Quantity Factor	Habitat Quality	Quality Factor
5+ miles	10	High	10
2 to 4.9 miles	6	Medium	6
1 to 1.9 miles	4	Low/Unknown	2
0.5 to 0.9 miles	2		
<0.5 miles	1		

4. Restoration Rating and Score

The restoration rating indicates priority or importance of the restoration needs or types addressed by a project. Except where noted below, the restoration rating is based on the EDT-derived multiple species restoration type ratings (High, Medium, Low) provided in the 6-Year Habitat Work Schedule for the reaches targeted by a project. For each reach, the ratings for the restoration types covered by the project are averaged and rounded up to the next highest rating. Based on NOAA's proposed Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead (NOAA, 2007), projects targeting estuary reaches and/or tidally influenced tributary reaches will receive a "high" restoration rating if their primary focus is:

• Restoration of degraded riparian areas; and/or Reconnection and/or restoration of floodplains, estuarine wetlands, and off-channel habitats. The overall restoration score indicates the extent to which it is estimated that a project will address its targeted restoration types or needs. The overall score is the sum of the reach restoration scores for each reach targeted by a project. The reach restoration score is sum of the scores for each restoration type proposed for the reach by the project. The score for each restoration type is the product of the restoration type rating (High=3, Medium=2, Low=1) times the number of habitat units times an effectiveness factor.

A habitat unit equals:
(1) 500 feet on both sides of the stream or 1000 feet on one side of the stream for riparian, floodplain, and hillslope process project types; or (2) 500 feet of stream length for instream and side-channel/off-channel project types. The effectiveness factor reflects a percentage estimate of the extent to which the project would address the project type within the targeted habitat unit. For example, if the project were deemed to be fully effective in creating instream habitat structure it would receive an effective factor of 100%. Initial effectiveness factors and the findings upon which they are based are developed by LCFRB staff and subsequently reviewed and revised as deemed appropriate by LCFRB Technical Advisory Committee (TAC).

The recovery plan and more recent assessments and studies identify marine- derived nutrients as an important element in supporting and maintaining stream ecosystem conditions needed by fish. However, a comprehensive survey and assessment of nutrient conditions in the Lower Columbia tributaries has not been conducted. Due largely to the lack of such survey data, the 6-Year Habitat Work Schedule does not identify reach-level

Nutrient Enhancement project needs. In scoring nutrient enhancement project proposals, a project type rating of medium will be used. In evaluating effectiveness, nutrient loading levels and the duration (years) of enhancement effort will be considered.

While many habitat project proposals include both design and implementation or construction phases, Design-only proposals may be submitted for large and/or complex restoration projects. A design project can help to ensure that a subsequent implementation/ construction project is technically sound, feasible, and maximizes fish benefits. However, while a design project can substantially enhance fish benefits and certainty of success of a restoration project, it does not produce tangible on-the-ground outcomes. Accordingly, design projects will be scored using an effectiveness factor of 50 percent (0.50) for a project producing a final design and 30 percent (0.30) for a project producing a preliminary design. Final and preliminary design levels are defined in SRFB Manual 18, Appendix D.

Assessment projects focus on evaluating habitat and watershed conditions, developing restoration strategies and identifying site specific restoration and/or protection opportunities in multiple reaches, a watershed, or Subbasin. Like design projects, they do not result in tangible on-the ground benefits. While they may produce conceptual designs, they do not result in detailed designs ready for implementation. Since assessments often involve multiple reaches, an average, rather than the sum, of their restoration benefits will be used. An effectiveness factor of 10 percent will be used for all project types being addressed in an assessment. Finally, the average restoration benefit score is weighted to give a higher priority to assessment focusing on comprehensive restoration prescriptions for multiple reaches. This is done by multiplying the average restoration benefit score for an assessment covering 5 or more reaches by a factor 1.25. An assessment covering 1 or 2 reaches is multiplied by 0.75.

d. Cost Score Each project is evaluated by the TAC to determine if the cost is reasonable relative to the likely benefits. This evaluation is based on professional judgment taking into consideration labor, material and administrative costs in comparison to past projects. The scoring range is 0 to 15 points.

Final Benefit Ratings and Scores

A project's overall benefit rating is a combination of the Population/Reach and PAR ratings and is determined using the following matrix. The overall benefit rating is combined with its certainty rating (described below) using the Table 1 matrix to establish a project's priority grouping.

Table 7. Overall Benefit Rating Matrix

		Protection/Access/Restoration Rating		
		High	Medium	Low
Population/Reach Rating	High	High	Medium	Low
	Medium	Medium	Medium	Low
	Low	Low	Low	Low

A project's overall benefit score is the sum of its Population/Reach Score, its PAR score and its Cost score. The maximum possible score is 200 points. The benefit score is combined with a project's certainty score and used to rank a project within its project priority group.

III. CERTAINTY OF SUCCESS

a. Introduction

The second project proposal evaluation category is Certainty of Success. While the Benefits to Fish category looks at how well a project targets important populations, reaches, and limiting factors and evaluates the potential benefits to fish, the Certainty category evaluates how likely a project is to achieve proposed outcomes or benefits. The Certainty of Success is given equal weight to Benefits in evaluating a project. The overall scoring range for Certainty of Success is 0 to 200 points. Additional detail on the factors considered by the TAC in scoring these categories can also be found in Attachment 1 (2009 Habitat Project Application Evaluation Questions).

b. Scoring Categories

Rating	Score Range (0 to 15)
High	11 to 15
Medium	6 to 10
Low	0 to 5

Projects should have a well-defined work scope that is tied directly to its stated goals and objectives. Clear connections between a project's work scope and its goals and objectives help assure that project sponsors have clearly identified how they will reach their stated goals and objectives.

The proper work scope and success of a project requires a solid understanding of conditions and watershed processes that cause or contribute to the problem or limiting factor being addressed. Projects with a scope and design that account for the causes of limiting conditions and processes will be given priority. For some projects, EDT, IWA, and existing LFA information may be sufficient. More complex problems may require a more thorough assessment of conditions and watershed processes. This information may be available through existing studies and evaluations. In some cases, additional site-specific assessments and design work may be needed.

2. Approach

Rating	Score Range (0 to 75)
High	51 to 75
Medium	26 to 50
Low	0 to 25

The certainty of a project's success can be enhanced through the use of proven and accepted methods and technologies. Projects should utilize approaches and technologies that are commensurate with the project's biological and habitat objectives and the nature, scope, and complexity of the problem being addressed. In selecting technologies to be employed in addressing a habitat attribute, sponsors should ensure that larger-scale watershed processes and conditions that can affect the project site have been identified and taken into account. Additionally, sponsors should clearly identify any potential impacts a project may have on upstream, downstream, and/or adjacent habitat.

Innovative or experimental approaches may be acceptable if no proven method exists or it can be shown that they will extend knowledge of restoration methodologies at a reasonable risk. In order to assess whether a project has an adequate supporting technical basis, it will be important that the project proposal addresses considerations listed for its project type contained in the Guidance on Watershed Assessment for Salmon, Part Three (Joint Natural Resources Cabinet, State of Washington, May 2001)

(Appendix XI). LCFRB technical staff and the WDFW Watershed Steward will help project sponsors identify existing documents that provide technical support for proposed projects.

For acquisition projects, the sponsor must establish why acquisition is the most appropriate method for achieving the project's goals. If fee title acquisition is proposed, the sponsor must explain why a less-than-fee approach, such as a conservation easement, would not achieve the project's goals. Finally, for any acquisition the sponsor must obtain the concurrence of the affected city or county.

Assessments, designs, and feasibility studies must utilize an approach that will effectively address a key information or data gap in the Recovery Plan or the 6-year Habitat Work Schedule or lead to the implementation of priority projects within 2 years.

3. Coordination and sequencing

Rating	Score Range (0 to 35)
High	24 to 35
Medium	12 to 23
Low	0 to 11

Habitat projects should be designed, coordinated, and sequenced in concert with other salmon recovery activities or needs within a watershed or basin. This can help achieve the greatest benefit to fish in the shortest possible time and with the most efficient use of resources.

Consideration will be given to whether a project is:

a. An element of an existing comprehensive watershed or basin restoration and protection strategy;
b. Well coordinated and logically sequenced with other habitat projects completed, underway, or planned for a watershed or basin; and/or
c. Complementary and supportive of other local and state salmon recovery regulations and programs, including land use and development regulations, critical area ordinances, storm water management programs, shoreline master plans, forest management regulations, etc.
d. A logical second phase of a project that had previously received SRFB funding. For example, an implementation project following from a previously-funded design project, or a restoration project following a previously-funded acquisition project.

4. Uncertainties and Constraints

Rating	Score Range (0 to 20)
High	14 to 20
Medium	7 to 13
Low	0 to 6

Each project is reviewed to identify funding, scientific/technical, legal, and/or physical constraints or uncertainties that could significantly impact successful completion of the project. The fewer constraints and uncertainties the higher the project will be scored.

5. Sponsor Qualifications (experience and capabilities)

Rating	Score Range (0 to 20)
High	14 to 20
Medium	7 to 13
Low	0 to 6

The success of a habitat project is dependent on the project sponsor's ability to design, plan, implement and monitor a project. Ideally, project sponsors should have experience in successfully completing projects of similar nature, scope, and complexity. At a minimum, sponsors should indicate how they would acquire needed experience and expertise that they do not possess. Options for doing so could include partnerships with other agencies or organizations, or contracting for needed services.

6. Community and Landowner Support

Rating	Score Range (0 to 25)
High	18 to 25
Medium	9 to 17
Low	0 to 8

The long-term success of habitat restoration and protection efforts depends on the acceptance and support of local communities. Projects should be designed and implemented in a manner that accommodates local values and concerns. LCFRB places a higher priority on projects that will provide long-term benefits for fish by also promoting community support and involvement in salmon recovery.

Having a willing landowner or owners is essential to the success of any on-the-ground project. No project can be implemented or maintained without the consent and support of the landowner. Given the critical importance of landowner support, LCFRB requires a written commitment from the landowner with all project proposals.

7. Stewardship (i.e. maintenance, operation and monitoring)

Rating	Score Range (0 to 10)
High	8 to 10
Medium	4 to 7
Low	0 to 3

The sponsor should identify how monitoring efforts would support maintenance of the project and who would perform maintenance and over what period of time. Maintenance of a completed project may be critical to the project's performance and long-term effectiveness.

c. Final Certainty Rating and Score

A project's overall certainty score is the sum of all certainty scoring factors described above. Based on its overall certainty score, each project is assigned a certainty rating of high, medium, or low certainty of success using the following scale, except if a project receives a "low" rating for any of the individual scoring factors in which case the TAC may assign the project an overall certainty rating of "low" if it concludes that the low factor rating indicates a substantial risk to the overall success of the project.

Table 8. Certainty Rating Table

Project Certainty Score	Project Certainty Rating
140 to 200 pts	High
71 to 139 pts	Medium
0 to 70 pts	Low

2/10/09 LCFRB Evaluation Criteria 11 of 11

Appendix 5.2. Lower Columbia Fish Recovery Board 2009 Habitat Project Application Evaluation Questions.

I.B. BENEFITS TO FISH

I.B.	**BENEFITS TO FISH**		
1.	**Cost: 0-15 pts.** Is the cost of the project reasonable in relation t the expected benefits?	**Rating** High Medium Low	**Score Range** 11 to 15 6 to 10 0 to 5

II. CERTAINTY OF SUCCESS

II.	**CERTAINTY OF SUCCESS**		
1.	**Scope: 0-15 pts.** ▫ Are the scope & scale appropriate to achieve the stated goals and objectives? ▫ Does the proposal have a well-defined scope that is consistent with and appropriate for the stated goals and objectives?	**Rating** High Medium Low	**Score Range** 11 to 15 6 to 10 0 to 5
2. **a.**	**Approach: 0-75 pts.** <u>Acquisition/Restoration Projects:</u> ▫ Does the proposal apply appropriate and proven methods and technologies? ▫ Does the proposed approach adequately provide for and incorporate watershed and site conditions that could affect its success? ▫ To what extent does the proposal address the causes of degraded habitat conditions rather than symptoms? ▫ To what extent does the proposal address how watershed conditions and processes will affect the long-term success of the proposed project? ▫ To what extent does the proposal identify and address potential positive and/or negative impacts on upstream, downstream, and/or adjacent habitat conditions? ▫ If acquisition, is this approach necessary to achieve the project's objective? ▫ What is the threat to the site? How imminent is the threat?	**Rating**	**Score Range**
	OR	High Medium Low	51-75 26-50 0-25
b.	<u>Assessments, designs and feasibility studies:</u> ▫ Will the proposed methodology effectively address an information gap identified in the recovery plan or habitat work schedule or lead to implementation of priority projects within two years? ▫ Will the project provide "critical" information needed to make effective and sound habitat or watershed restoration decisions? ▫ Will the proposed approach adequately address watershed and site conditions? ▫ Will the proposed project address causes of degraded watershed processes and/or habitat conditions rather than symptoms?		

II.	**CERTAINTY OF SUCCESS Continued**		
3. **a.**	**Coordination/Sequence: 0 to 35 points** <u>Restoration/Acquisition Projects:</u> ◦ Is the proposal designed and located in coordination with other salmon recovery activities in the reach or watershed? ◦ Is it logically sequenced with other restoration needs or projects in the reach or watershed? ◦ To what extent does the proposal address degraded watershed processes and/or habitat conditions in a manner supportive of and compatible with other restoration efforts in the watershed? ◦ Is the project a logical next phase after a previously-funded SRFB project (implementation following a design project; restoration following acquisition, etc)?	**Rating**	**Score Range**
	OR	High Medium Low	24 to 35 12 to 23 0 to 11
b.	<u>Assessments, designs and feasibility studies</u>: ◦ Are the scope, scale, approach, and methods compatible with similar assessments within the watershed and/or region?		
4.	**Constraints/Uncertainties: 0 to 20 points** ◦ What is the potential for funding, scientific/technical, permitting, legal, and/or physical constraints or uncertainties to affect successful implementation of the project? Considerations: permitting, site conditions, access or anthropogenic factors.	**Rating** High Medium Low	**Score Range** 14 to 20 7 to 13 0 to 16
5.	**Qualifications and Experience: 0 to 20 points** ◦ How qualified and experienced is the project team (sponsor and partners) in successfully undertaking projects of similar scope, nature, and magnitude? ◦ <u>Considerations</u>: Demonstrated project management abilities, successful follow through with completing projects on time and within budget.	**Rating** High Medium Low	**Score Range** 14 to 20 7 to 13 0 to 6
6.	**Community Support: 0 to 25 points** ◦ What is the extent of community support for and involvement in the proposal? ◦ <u>Considerations</u>: Has the sponsor obtained significant inkind or cash match? Will local volunteers participate? Will it enhance public knowledge and support? Will it build capacity and interest for future project work? Does the project address local concerns and interests? Is the landowner willing to allow the proposed work to be done?	**Rating** High Medium Low	**Score Range** 18 to 25 9 to 17 0 to 8
7.	**Stewardship and Maintenance: 0 to 10 points** ◦ To what extent does the proposal describe stewardship or maintenance efforts for ten years or more?	**Rating** High Medium Low	**Score Range** 8 to 10 4 to 7 0 to 3

Appendix 6. LCFRB (2004) Salmon Recovery Plan Strategies for artificial production.

6.7.2 Strategies H.S1.

Expand use of hatchery reintroduction and supplementation programs to conserve and recover naturally-spawning fish when and where appropriate. Explanation: Conservation hatchery programs will be a critical tool in salmon recovery throughout the lower Columbia River. Hatchery programs historically concentrated on production for harvest but recent experience has demonstrated that hatcheries can make substantial contributions to naturally-spawning salmon conservation. Conservation hatchery programs will be a key to reintroduction efforts in areas where access or suitable habitat is restored. Carefully designed supplementation programs can also be used to maintain viable naturally-spawning populations in the interim until adequate habitat improvements occur, or in cases where the appropriate brood stock is chronically under-seeding the habitat. Many conservation programs have already been initiated but additional modifications of existing hatchery programs and new programs will be needed.

6.7.4 Actions Chum

H.A13. Develop additional chum supplementation programs. (Category C) Explanation: Hatcheries will play a key role in rebuilding lower Columbia chum populations. Recent year spawning surveys indicate remnant chum populations present in many tributary streams of the lower Columbia River. However, the majority of these populations are critically low in numbers. The unique attributes of the lower Columbia chum populations will be preserved and maintained with hatchery program support. Supplementation programs would be developed on a parallel track with habitat enhancement programs in the watersheds. This approach, however will not be needed in areas where chum demonstrate the ability to naturally colonize new access areas and respond quickly to improved habitat. Hatchery Genetic Management Plans will be need to be developed and broodstock sources identified for many of these proposed supplementation programs.

STRATEGIES AND MEASURES

6-56 H.A14. Continue to enhance local chum populations using Grays and Chinook hatcheries. (Category A) Explanation: Grays River chum stock is currently utilized to rebuild the chum population in the Chinook River and as a risk management tool for the Grays River population. The Grays River brood stock program may be expanded to include supplementation of other coastal stream populations, dependent on genetic similarities between Grays River and other chum populations. Expanding the Grays supplementation program should only be considered if sufficient Grays River brood stock were available to support the hatchery program without risking the Grays River natural population.

H.A15. Use hatcheries for chum enhancement and risk management in the lower Columbia River Gorge. (Category A,C) Explanation: The Washougal Hatchery chum program supplements the Duncan Creek chum population and provides the facilities for risk management of the mainstem Columbia population at Ives Island and Hamilton and Hardy creek populations. Risk management options are assessed annually and implemented when low flow conditions compromise the ability of adult chum to access spawning areas. The Washougal Hatchery program is a good example of the role hatcheries should play in rebuilding lower Columbia chum populations. The Washougal Hatchery chum program concept could be expanded to include additional hatcheries and support additional populations.

H.A16. Use DNA data to select appropriate chum brood stock. (Category B) Explanation: DNA samples from chum spawning in the mainstem lower Columbia and tributaries have been collected in recent years. Results from DNA analysis will inform strategies for developing specific hatchery programs which are consistent with specific traits of individual populations.

H.A17. Develop and apply hatchery brood stock watershed transfer policies for chum. (Category B) Explanation: Chum releases into the Grays and Chinook rivers would only include Grays River stock, and chum releases into lower Gorge streams would include lower Gorge stocks. Transfer policies would be further developed based on DNA analysis results and would be adaptive over time as sustainable populations are established in more watersheds and more hatcheries are used for chum supplementation and risk management programs.

Appendix 7. HSRG (2008a) strategy for implementing conservation hatchery programs to rebuild LCR chum populations.

The framework for a conservation strategy is defined through recent state and federal recovery planning efforts. The managers want at least two chum populations within each stratum to meet the standards of a Primary population.

The HSRG reviewed options for chum conservation in the lower Columbia River in the context of conservation goals for other salmon and steelhead ESUs as well as the objectives of fisheries managers for Chinook and coho harvest. Based on this broader context, the HSRG notes that conservation goals for the chum population in the Youngs Bay tributaries (as a Primary population) may be in conflict with conservation and harvest goals for coho salmon in this area. Timing of intensive gill-net fisheries in Youngs Bay to fully harvest hatchery-origin coho overlaps with the return of adult chum salmon. Furthermore, the release of large numbers of juvenile Chinook and coho salmon from net pens in this area may also cause excessive predation on migrant chum fry. Other chum populations in the Coast stratum are more likely to achieve the status of a Primary population in a manner that is compatible with the managers' goals for Chinook and coho.

Harvest of chum salmon is incidental, occurring primarily in the lower Columbia River commercial coho fishery. Sport harvest of chum in the Columbia River and tributaries has been closed since 1992 in Oregon and 1995 in Washington. The presumption is that chum salmon are not harvested in the ocean or in the Columbia River above Bonneville Dam. Fishery managers set a 5% maximum incidental harvest mortality on Columbia River chum. Recent harvest rates are reported to have averaged about 1.6% annually (FCRPS BiOp). Because of the potential for misidentification of chum caught in intensive coho fisheries, the HSRG recommends field confirmation of this harvest rate.

Chum hatchery programs have been associated with increased abundance of natural chum populations, most notably summer chum in Puget Sound. Hatchery chum populations are less likely to be affected by domestication given their short-term culture. There are currently two hatchery conservation programs for chum salmon in the Columbia Basin, Grays River/Chinook River (WA) in the Coast stratum, and Duncan Creek (WA) in the Gorge stratum (Table 4).

The HSRG notes that 13 of 16 historical populations of Columbia River chum salmon are severely depressed even though Washington's Lower Columbia River Recovery Plan indicates habitat is available to support much larger populations. Under current habitat conditions, managers estimate an ESU abundance of 24,000 chum salmon can be supported. With habitat improvements to tributaries, an estimated ESU abundance of 115,000 chum salmon is possible.

Hatchery intervention can reduce demographic risk by boosting abundance. Additional conservation propagation programs should be promptly initiated within each of the ESU's three geographic strata to reduce this risk. Existing and candidate populations for hatchery conservation programs are identified in Table 4. Chum conservation programs can be rapidly implemented at existing facilities at modest cost. Programs should be sized at 100,000 to

200,000 fry releases. These programs should last up to three generations. Broodstock should be selected from the target population, or in the case of reintroductions, from the most suitable available population.

The need for hatchery intervention has been recognized by others and funding appears to be available to pursue chum hatchery programs following more detailed planning. We recommend planning be immediately initiated leading to one or two programs for initial implementation in each stratum. The planning process should also include the development of a set of hypotheses regarding the likely causes of the decline of chum. Based on these hypotheses, the role and objectives of conservation hatcheries in a comprehensive recovery plan should be defined. Additional reintroduction or other conservation programs could then be considered based on monitoring and evaluation results.

In summary, the use of chum conservation programs should be viewed as an important short-term risk management strategy to preserve the genetic legacy of depressed chum populations. Managers also need to better understand what has caused the overall chum decline and what ecological and/or demographic factors are continuing to keep the ESU at such low abundance levels given the apparent available habitat capacity and propensity for salmon populations to be highly productive at low abundances. Managers should avoid maintaining this ESU only through artificial propagation due to long-term hatchery risks of domestication and fitness loss.

Table 4. Existing and HSRG-proposed propagation programs for conservation and recovery of chum salmon.

Populations	Existing Conservation Programs	Potential Conservation Programs	Potential Control Populations
Coast Stratum			
Grays/Chinook (WA)	Grays/Chinook		
Elochoman (WA)		Elochoman	
Mill/Abernathy/Germany (WA)		Abernathy	Mill/Germany
Youngs Bay Tribs. (OR)			Klaskanine/Youngs
Big Creek (OR)		Big Creek	
Clatskanie (OR)		Clatskanie	
Scappoose (OR)			Scappoose
Cascade Stratum			
Cowlitz (WA)			Cowlitz
Kalama (WA)			Kalama
Lewis (WA)		Lewis	
Salmon (WA)			Salmon
Washougal (WA)		Washougal	
Clackamas (OR)			Clackamas
Sandy (OR)		Sandy	
Gorge Stratum			
Lower Gorge Tribs.	Duncan		Hamilton/Hardy
Upper Gorge Tribs.		Wind, White Salmon	Hood

Appendix 8. Draft Columbia River Chum Salmon Recovery Strategy for Oregon's Lower Columbia River Coastal Stratum Tributaries April 22, 2009. (excerpt from ODFW 2009).

The over-arching goal of Oregon's recovery strategy is to develop a science-based approach utilizing the best available technical information to reduce risk, ensure success, and inform adaptive management. To increase the likelihood for success, Oregon has conducted an extensive review of existing scientific literature, incorporated recommendations from the Hatchery Scientific Review Group (HSRG), and evaluated and discussed various aspects of habitat requirements, reintroduction, artificial propagation, and population dynamics with fishery managers with expertise in these fields. We focused the scope of our technical review based on 8 key elements that served as the foundation for development of the CRS:

Framework for CRS Development

1. **Identify Methods for Re-Establishing Chum Populations**
2. **Identify Target Populations**
3. **Identify Habitat Suitable for Chum**
4. **Identify and Obtain Brood Source for Use in Reintroduction**
5. **Identify Facilities for use in Conservation Hatchery Program**
6. **Identify Production Goals and Program Duration**
7. **Identify Artificial Production Techniques**
8. **Identify Release Strategies for Reintroduction Program**

Recommendations: Based upon our initial technical review and evaluation, we recommend that initial efforts for recovery into coast stratum populations in the ESU occur within the Clatskanie and Scappoose population areas. This is consistent with recommendations from the HSRG who indicated that ODFW should implement a conservation program in these areas using locally available chum broodstock or other suitable donor populations. These populations each contain a considerable amount of HIP spawning habitat (see Framework Element 3 below) and our evaluation indicates that critical risks such as predation by hatchery fish and harvest in lower river commercial fisheries could be smaller relative to other areas.

Appendix 9. RPA 35 Tributary Habitat Implementation 2010-2018 – Achieving Habitat Quality and Survival Improvement Targets (NOAA Fisheries 2008 FCRPS BiOp).

The Action Agencies will identify additional habitat projects for implementation based on the population specific overall habitat quality improvement still remaining in Table 5 below. Projects will identify location, treatment of limiting factor, targeted population or populations, appropriate reporting metrics, and estimated biological benefits based on achieving those metrics. Pertinent new information on climate change and potential effects of that information on limiting factors will be considered.

a) During 2010 to 2018, the Action Agencies will provide funding and/or technical assistance to implement specific habitat projects to achieve the specified habitat quality improvements listed in Table 5. Habitat quality improvements associated with projects will be estimated in advance of project selection by expert panels. The Action Agencies will convene expert panels to estimate changes in habitat limiting factors from the implementation of Action Agency habitat actions.

- The Action Agencies shall convene an expert panel to evaluate the percent change in overall habitat quality at the population scale from projects implemented previously (if quantitative objectives not met) and projects proposed for the implementation until the next check-in.
- The expert panel will use methods consistent with the *NWR v. NMFS* Remand Collaboration Habitat Workgroup process.
- Project proposals will clearly describe the completed project in terms of quantitative habitat metrics which can be used to quantitatively evaluate progress and completion of individual projects.
- The Action Agencies will use the expert panels to provide input on changes in habitat quality and function as a result of limiting factor improvements from project actions for the priority population areas and this information will be used to assess improvements to salmonid survival.

If actions from the previous cycle prove infeasible, in whole or in part, the Action Agencies will ensure implementation of comparable replacement projects in the next implementation plan cycle to maintain estimated habitat quality improvements at the population level and achieve equivalent survival benefits. If infeasible at the population level, then alternatively replacement projects will be found to provide benefits at the MPG or ESU/DPS level. Selection of replacement projects to ensure comparable survival benefits will be made based on input from expert panels, regional recovery planning groups, the Northwest Power and Conservation Council, and NOAA Fisheries. The Action Agencies will continue to work cooperatively with the Council to identify priorities and obtain ISRP review of projects proposed for BPA funding.

- RM&E will inform the relationship between actions, habitat quality and salmon productivity for use in a model developed through the FCRPS RM&E Strategy 3, Action 57 and new scientific information will be applied to estimate benefits for future implementation.

- If new scientific or other information (except incomplete implementation or project modifications) suggests that habitat quality improvement estimates for projects from the previous cycle were significantly in error, the Action Agencies will examine the information and review the project or projects in question and their estimated benefits. This review will occur as part of the 2009 Annual Report and the Comprehensive RPA Evaluations in 2013 and 2016 and will be performed in conjunction with NOAA Fisheries.

In the event such review finds that habitat quality improvement benefits were significantly overstated, the Action Agencies will implement replacement projects (selected as per Action 35 above) to provide benefits sufficient to achieve the habitat quality improvement and population-or MPG-specific survival benefit estimated for the original project or projects.

b) During 2010-2018, for non-bolded populations in Table 5, the Action Agencies may provide funding and/or technical assistance for replacement projects should they become necessary for the Action Agencies to achieve equivalent MPG or ESU survival benefits.

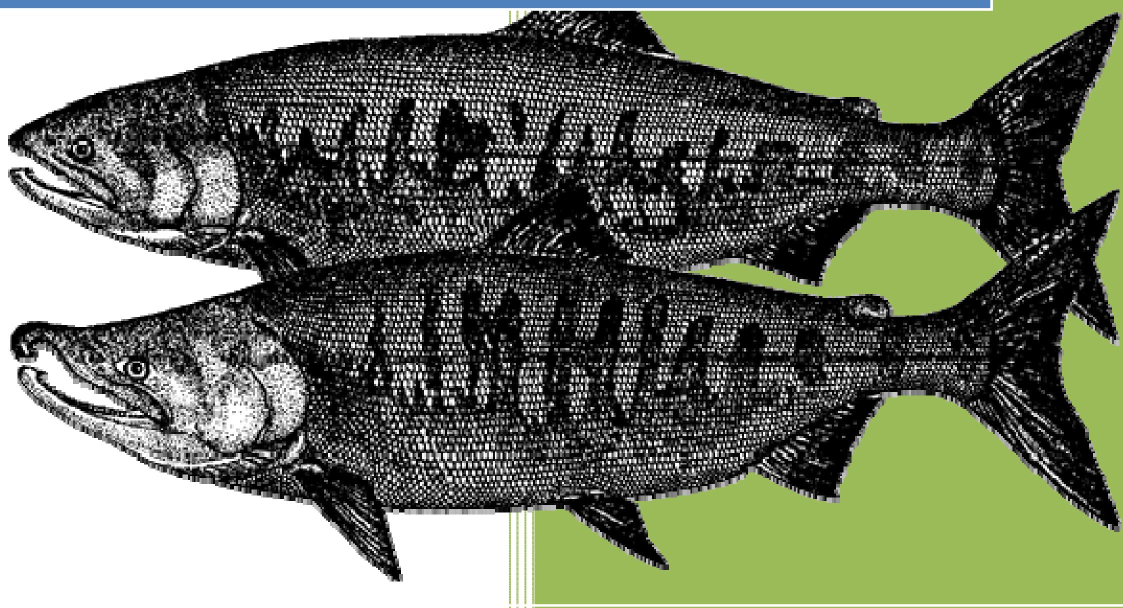
c) For those lower Columbia populations above Bonneville Dam that have been significantly impacted by the FCRPS (CR chum, LCR coho, LCR Chinook, and LCR steelhead) the Action Agencies may provide funding and/or technical assistance for habitat improvement projects consistent with basin wide criteria for prioritizing projects, including Recovery Plan priorities.

ATTACHMENTS

Attachment 1. Updated Proposal: Chum Salmon Enhancement in the Lower Columbia River – Development of an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam. Note: Changes and additions to the proposal are in blue font; narrative from the January 7, 2009 version remains in black font.

Project 2008-710-00

ATTACHMENT 1. Revised BiOp Proposal Incorporating WDFW Response to ISRP Review: "Chum Salmon Enhancement in the Lower Columbia River – Development of an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam."



Revision by: Steve Vigg, Columbia River Projects Coordinator, Bryce Glaser, Anadromous Fish Unit Leader, and Todd Hillson, Chum Project Leader

Washington Department of Fish & Wildlife, Region 5, Vancouver, Washington

06/05/2009

Attachment 1. Updated Proposal: Chum Salmon Enhancement in the Lower Columbia River –Development of an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam. Note: Changes and additions to the proposal are in blue font; narrative from the January 7, 2009 version remains in black font.

Chum Salmon Enhancement in the Lower Columbia River – Development of an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam.

WASHINGTON STATE
DEPARTMENT OF FISH AND WILDLIFE
FISH PROGRAM

Prepared by
Bryce Glaser, Todd Hillson and Steve Vigg

Region 5 – Fish Management
2108 Grand Blvd.,
Vancouver, Washington

Revision Incorporating ISRP Comments: June 5, 2009

Table of Contents

List Of Tables

List of Figures

Page

BACKGROUND

The foundation for ongoing chum restoration has been developed by the "all-H" comanagers through the collaborative FCRPS Remand / Biological Opinion (BiOp) process during recent years. The Bonneville Power Association (BPA) identified two new "BiOp Projects" relating to the Columbia River chum salmon Evolutionarily Significant Unit (ESU) – BPA project #'s 2008-710-00 and 2008-711-00, in its Start of Year (SOY) budget spreadsheet for FY 2009 projects:

- 2008-710-00 (Assess habitat potential for reintroduction of CR chum) and
- 2008-711-00 (Implement chum reintroduction below Bonneville Dam).

These projects had a combined funding total of $500K as a placeholder in the BPA project management system – PISCES.

Throughout this proposal we use technical terms and scientific jargon that requires a common understanding to facilitate effective communication with the reader; for example:

We use the term **reintroduction** in the context of a Recovery Goal for LCR chum in habitats that they have been functionally extirpated.

We define **supplementation** as an implementation strategy to achieve the goals of reintroduction and recovery.

Artificial production is a tool that can be used in various ways to implement a supplementation strategy.

We refer the reader to the Glossary of Terms (Appendix 1) for future reference.

Purpose of Project 2008-710-00

The purpose of the work proposed by WDFW is to promote recovery of LCR chum salmon populations through the development of an integrated program for chum salmon habitat restoration and supplementation/ reintroduction in FFY 2009 (Phase 1), followed by full implementation of the program in FFY 2010 (Phase 2).

Phase 1 program development in FFY 2009 includes the following components:

1) An assessment of priority habitat restoration and/or chum channel sites;
2) An updated stock status review of LCR chum salmon population structure and abundance necessary to prioritize restoration and guide future implementation of supplementation/reintroduction;
3) Adaptive management of ongoing and proposed supplementation programs – in conjunction with the M&E plan (below);

4) Development of a stepwise enhancement program that utilizes supplementation /reintroduction to rebuild LCR chum populations
5) Development of a comprehensive program to monitor LCR chum salmon populations and evaluate the effectiveness of habitat restoration and supplementation/reintroduction actions.

Rationale for Conducting Chum Reintroduction & Habitat Restoration

We provide the scientific rationale for implementing a chum reintroduction program in the LCR based on concurrent supplementation and habitat restoration strategies (Appendix 2). The following sections discuss the rationale in terms of ESA Recovery mandates through the FCRPS Biological Opinion and coordination with major concurrent habitat restoration programs in the LCR and estuary.

NOAA Fisheries Service FCRPS Biological Opinion

The project is intended to implement several actions required by the 2008 FCRPS BiOp RPAs:

a) RPA action 42: "Fund a hatchery program to re-introduce chum salmon in Duncan Creek including capital construction, implementation and monitoring and evaluation as long as NOAA Fisheries considers it beneficial to recovery and necessary to reduce risk of the target population." This is essentially the ongoing work previously funded under Project 2001-053-00, Reintroduction of Lower Columbia Chum Salmon into Duncan Creek, and now proposed for inclusion in Project 2008-710-00."
b) RPA action 42: "Fund the assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River tributaries below Bonneville Dam." This is new work. "
c) RPA action 17: "The project will contribute to monitoring of chum salmon spawning in the mainstem Columbia River in the area of the Ives Island Complex and/or access to the Hamilton and Hardy Creeks for this spawning population."

The Federal Action Agencies have developed both habitat and hatchery-related proposed actions for LCR chum salmon -- in support of the Biological Opinion for the Federal Columbia River Power System (FCRPS) (Federal Agencies May 21, 2007; Source: www.salmonrecovery.gov). The enhancement approach that we propose for chum salmon in this proposal incorporates both habitat improvement, reintroduction and hatchery supplementation actions.

Proposed Actions - Habitat Enhancement

Degradation of tributary habitat is a limiting factor for almost all chum salmon populations in the LCR -- although the nature and magnitude of this impact varies by location. Priority locations for chum habitat enhancement actions are based on biological needs and potential for benefits. Various methods can be used to protect and improve tributary habitat for chum salmon in the LCR tributaries. The following strategic approach is outlined in the FCRPS Biological Opinion proposed actions (Federal Action Agencies 2007).

The specific Objective, Strategy, and Actions for Habitat follows:

- **Objective** for All ESUs is to “Protect and improve tributary and estuary habitat to improve fish survival.
    - **Habitat Strategy 1:** Protect and improve tributary habitat based on biological needs and prioritized actions that address limiting factors identified for each ESU.
        - **Action:** Implement expanded tributary habitat program with particular (but not exclusive) focus on populations with greatest biological need (productivity less than 1) and where there is potential for improvement in tributary habitat. Proposed actions address key limiting factors to:
            - Increase streamflow through water acquisitions
            - Address entrainment through screening
            - Provide fish passage and access
            - Improve mainstem and side channel habitat conditions
            - Protect and enhance riparian conditions.
            - Improve water quality

Proposed Actions - Hatchery Supplementation

Chum populations at high risk of extinction can be preserved through artificial propagation safety-net programs until limiting factors can be addressed. Properly designed and implemented artificial propagation conservation programs can improve abundance, spatial structure, and diversity of natural spawning populations.

The specific Objective, Strategy, and Actions for Hatcheries follows:

- Objective for all ESUs: Fund FCRPS mitigation hatchery programs in a way that contributes to reversing the decline of downward-trending ESUs and DPSs.
    - **Hatchery Strategy 2:** Use safety-net and conservation hatchery programs to assist recovery of ESA-listed ESUs and Distinct Population Segments.
        - **Action for Columbia River Chum Salmon:** Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation programs for chum salmon in selected LCR tributaries below Bonneville Dam.

WDFW is proposing the development of chum channels – at selected sites – as part of our reintroduction and supplementation approach. This proposal addresses the following criteria – under development by the Action Agencies and others – to rank implementation projects for 2010-2017:

- The project addresses the key limiting factors for chum salmon identified in the LCFRB recovery plan;
- The targeted chum salmon populations currently have low productivity;
- The projects will benefit more than one chum population within the chum ESU;
- The project will provide immediate benefits by increasing chum abundance;
- The VSP parameters will be considered and improvements made.

Although hatchery supplementation would target populations with low productivity, adequate adult chum abundance is needed to initiate a program. In cases where habitat quality is also very limited, we need to combine other actions – such as instream habitat enhancements or the development of chum channels – in conjunction with a supplementation program.

Work under 2008 BiOp Estuary Habitat RPAs and the WDFW-Federal Action Agency "Estuary MOA" adds $90 Million in new Habitat Restoration Work Below Bonneville Dam

Other major actions that have occurred since the writing of the LCFRB (2004) Recovery Plan are implementation and completion of significant restoration projects – plus greatly increased funding for habitat restoration in the Columbia River Estuary[1] authorized for the next decade:

- Ongoing and completed tributary habitat restoration projects selected by LCFRB for Salmon Recovery Funding Board (SRFB) funding during 2004-2009;
- Lower Columbia River Estuary Partnership (LCREP) habitat projects ongoing and completed in the lower estuary (refer to Figure 1);
- NOAA Fisheries Service's May 2008 FCRPS BiOp authorized $49.5 million to conduct estuary habitat work over the next 10-years – largely in coordination with the Estuary Partnership;
- The WDFW "estuary MOA", will fund an additional $40.5 million of estuary habitat restoration during 2010-2018 – with a goal of significantly enhancing survival of stocks of anadromous salmon and steelhead listed under the ESA

In 2008, the federal action agencies had previously dedicated $49.5 million to estuary habitat work over the 10-year course of NOAA Fisheries Service's May 2008 Federal Columbia River Power System biological opinion. The BiOp includes a "reasonable and prudent alternative" that describes operational improvements and off-site mitigation actions, such as habitat improvements, that would be implemented to improve fish survival and avoid jeopardy. Judge Redden is concerned about the adequacy and uncertainty of habitat provisions in the FCRPS BiOp: "*The most serious flaw in it is the habitat and in particular the estuary habitat…*"

Under a recently negotiated MOA between federal action agencies and the state of Washington, WDFW will lead efforts to identify and rank the priority of potential habitat enhancement actions

[1] For the 2008 NOAA Fisheries FCRPS BiOp, the "estuary" is defined as the reach from the mouth of the Columbia River to Bonneville Dam including lower tributary reaches having tidal influence.

from the mouth of the Columbia River to Bonneville Dam including lower tributary reaches having tidal influence. WDFW and partners will then sponsor on-the-ground projects -- funded by BPA and the U.S. Army Corps of Engineers (Corps) -- to protect and restore estuary habitat used by 13 species of anadromous salmon and steelhead listed under the auspices of the ESA. The initial proposed list of new projects (coded yellow) – along with ongoing LCREP habitat restoration projects is illustrated in Figure 1.

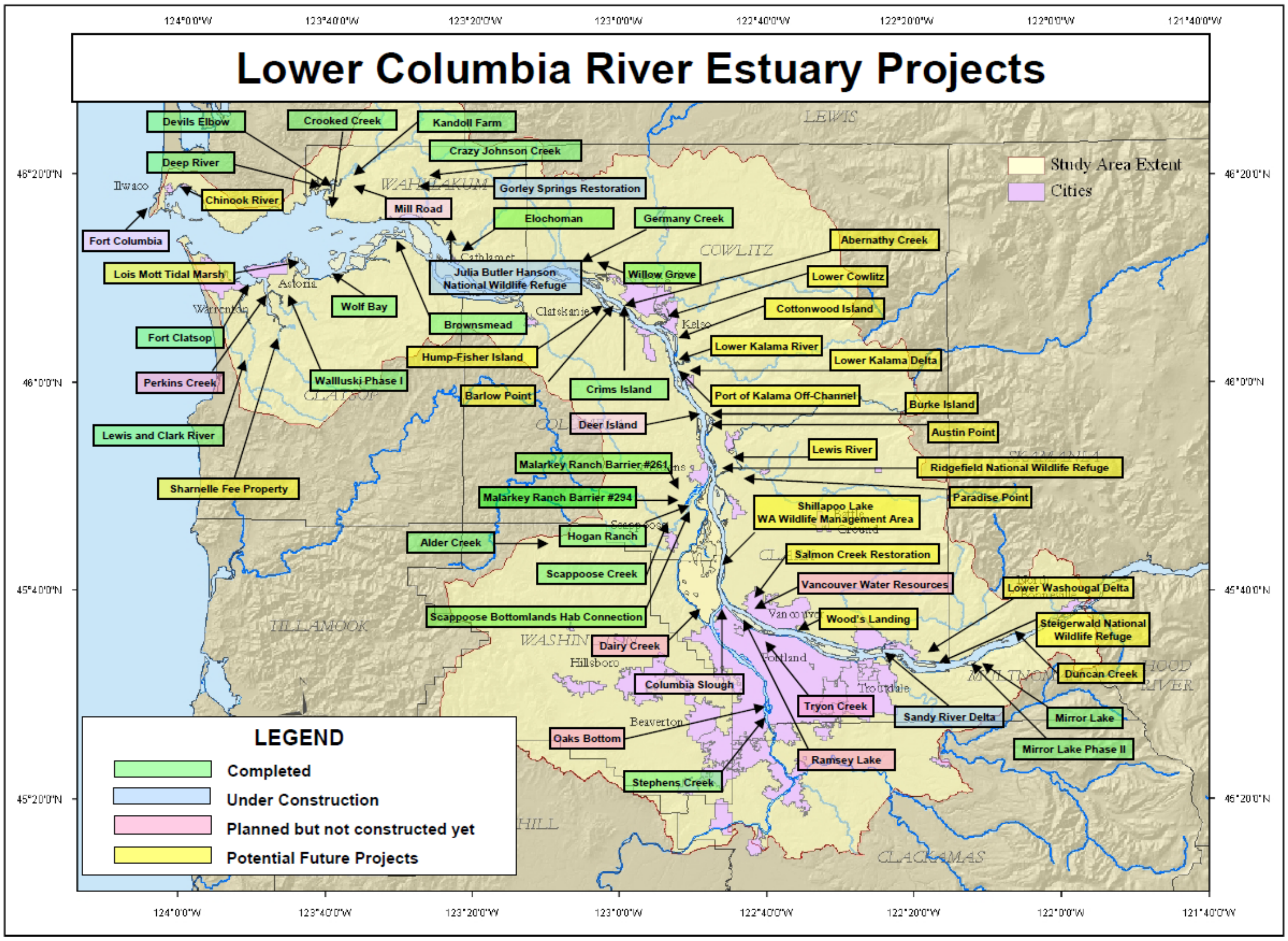


Figure 1. Estuary habitat restoration projects – completed, under construction, planned for 2009, and potential future projects for 2010 and beyond (Source USACE April, 2009).

The WDFW "estuary MOA", announced April 3, 2009, would almost double the amount spent on estuary habitat restoration – an additional $40.5 million ($4.5 million annually) during 2010-2018 – with a goal of significantly enhancing survival of listed stocks of anadromous salmon and steelhead listed under the ESA. The MOA takes advantage of Corps cost-sharing programs for habitat improvements. The WDFW will apply BPA funds, provided by ratepayers, to leverage matching federal appropriations for its 536 Program, which the Corps will seek from Congress.

The WDFW Estuary MOA contract with BPA will fund a coordinator position for WDFW (0.5 Full Time Equivalent (FTE)) plus 1 FTE each for WDFW and LCFRB to work collaboratively with LCREP and all relevant partners to identify and sponsor high impact projects for submittal to the Corps 536 Program[2]. Therefore, WDFW will be in an excellent position to coordinate the habitat project selection criteria, and the lists of high priority new, ongoing, and completed projects – as candidates for integration with the chum enhancement Project 2008-710-00 restoration and supplementation efforts.

Hatchery Scientific Review Group (HSRG) Recommendations

The Hatchery Scientific review Group (HSRG 2008a) provided recommendations for implementing of conservation hatchery programs for chum salmon in the Columbia River ESU (Appendix 3). The HSRG recommends several small (100,000-200,000 fish programs) chum salmon conservation/supplementation hatchery programs. The goal of these programs would be to reduce demographic risk by boosting abundance and to preserve the genetic legacy of depressed chum salmon populations. The HSRG recommended conservation propagation programs be initiated within each of the ESU's three geographic strata.

Additionally, the HSRG recommends that the planning process should also include the development of a set of hypotheses regarding the likely causes of the decline of chum. Based on these hypotheses, the role and objectives of conservation hatcheries in a comprehensive recovery plan should be defined. Additional reintroduction or other conservation programs could then be considered based on monitoring and evaluation results. They also stated: Managers should avoid maintaining this ESU only through artificial propagation due to long-term hatchery risks of domestication and fitness loss.

Review of Factors for Decline and Limiting Factors for Chum Salmon in Lower Columbia River.

Original Abundance of Chum Salmon in the Columbia Basin

Estimates of the pre-development level of total anadromous salmonid adult spawning run size in the Columbia River have varied widely – from 6.2 to 16 million fish per year (Table 1). The methodology used by Chapman (1986) probably provides the best estimates; i.e., an annual run size of 7.5 to 8.9 million salmonids during 1880-1920.

[2] The BPA-WDFW estuary MOA funding is expected to be authorized in June 2009.

Table 1. Estimates of the pre-development level of total abundance of anadromous salmon and steelhead adults; and tribal catches.

Abundance	Reference	Basis
Abundance of Salmon and Steelhead (Number of adult spawners)		
10-16 Million	NPPC (1986)	Historical levels/ Aboriginal use
7.5 to 8.9 Million	Chapman (1986)	Commercial catches and exploitation rates, 1880-1920
6.2	PFMC (1979)	Pre-development Habitat Availability (salmon)

Chapman (1986) estimated the peak period runs of Columbia River chum salmon at 449,000 to 748,000 adult spawners during 1915-1919. This corresponds to a relative abundance of about 6 percent of the total salmon and steelhead run size in the Columbia Basin. Chapman (1986) states that his chum salmon abundance estimate is probably low since chum salmon were produced in small streams in the lower Columbia and their habitat may have been reduced by logging and other activites by 1915.

Factors for Decline

Factors for Columbia River chum salmon decline in the broad "all-H" context are similar to other anadromous salmonid species, except hatcheries have had relatively negligible impacts on chum salmon in the Columbia River compared to other species:

- **Harvest** (directed and incidental),
- **Hydropower** (Federal Columbia River Hydropower System, FCRPS),
- **Habitat** (tributary and estuary), and
- **Hatcheries** (Hatchery chum populations are less likely to be affected by domestication given their short-term culture (HSRG 2008a)[3].

These major categories of causes for decline have changed in importance over time for LCR chum salmon (Table 2). The chronology of changes of specific impacts in Table 2 is qualitative; however, a discussion with more quantitative facts will be presented in the following sections of this response document.

Table 2. Effects of major causes for decline of Columbia River chum salmon over time: 1860's to present and future.

Time Period	Directed Harvest	Incidental Harvest	Hydropower (FCRPS)	Habitat (tributary & estuary)	Hatcheries – Artificial Production
Prior to 1865	negligible	negligible	none	Low impact	none
1866-1892	negligible	negligible	none	Low Impact	none
1893-1936	High impact (Craig and Hacker 1940)	negligible	none	Medium impact	negligible

[3] Over the past decade, two hatchery conservation programs have operated for chum salmon in the Columbia Basin: Grays River/Chinook River in the Coast stratum, and Duncan Creek (currently un-funded) in the Gorge stratum.

Time Period	Directed Harvest	Incidental Harvest	Hydropower (FCRPS)	Habitat (tributary & estuary)	Hatcheries – Artificial Production
1937-1955	High Impact (WDFW/ODFW 2002)	Low Impact	High impact (Bonneville 1938)	Medium impact	Low Impact
1956-1965	Medium Impact	Low Impact	High impact (The Dalles 1957)	Medium impact	Low Impact
1965-1998	Low impact	negligible	High impact	High impact	Low impact
1999 to present[4]	negligible	negligible	High impact	High impact	negligible to Low impact
Future Decade	negligible to Low impact	negligible	High impact	High impact	negligible to Low impact

Anthropogenic Impacts

Many human-caused factors can adversely affect anadromous salmonid survival and production during the life cycle; including:

- Withdrawal of water from the river for irrigation or municipal water supply (reducing water quantity); and juveniles lost to unscreened or inadequately screened pumps and diversions.
- Man-made dams and reservoirs in the lower river that inhibit, delay, or block adult upstream migrations or divert or disorient downstream juvenile migrations.
- Culverts, irrigation diversions, ineffective passage facilities, and other in-stream obstructions that delay or block fish movements and migrations.
- Loss of spawning and rearing habitats through dyking and channelization.
- Water pollution caused by agricultural return flows (pesticides and fertilizers), industrial effluents (toxicants) or domestic sewage (excessive nitrogen and phosphorous) in the riverine environment.
- Increased erosion, turbidity and sedimentation – along with altered temperature and hydrologic conditions – caused by alteration of riparian vegetation, logging, construction, road building, agriculture or other watershed activities.
- All of the pollutants and suspended sediments that enter the tributaries and rivers eventually end up in the environment and food webs of the mainstem lower Columbia River, the estuary, and the offshore plume.
- Changes in stream migration routes and obstructions, water temperature, flow patterns, and chemical composition that would affect returning salmon's homing behavior and physical ability to return to natal streams.
- Physical disturbance of the streambed, channelization, dredging, or removal of sand & gravel.
- Introduction of invasive/exotic species; including resident fish species (walleye, bass, catfish) that are predators on salmonid juveniles.

[4] Columbia River Chum salmon were listed as "threatened" under the ESA in 1999.

- Construction of reservoirs or in-river structures or creation of dredge-spoils islands that create habitat or increase reproduction and population size of predator species (fish, birds and/or mammals).
- Upriver storage reservoirs in the upper river that change the shape of the seasonal hydrograph and volume of flow.
- Direct mortality of adults for hatcheries, harvest, and illegal take (poaching).
- Mortality of juveniles due to predation by and competition with hatchery-produced salmonids, and mortality caused by illegal harvest in "trout" fisheries and other forms of illegal take (e.g., unscreened irrigation and small hydropower diversions).
- Loss of genetic fitness due to hatchery domestication.
- Reduction of marine derived nutrients in tributaries due to decreases in spawning run sizes; and reallocation of marine derived nutrients to mainstem areas via the long-term shift of biomass from anadromous salmonids to American shad.

Brief Review of Chum Salmon Biology – Relative to Limiting Factors

River habitat conditions and human activities affect the migration, spawning, and reproductive success of anadromous salmon. Water quantity (volume and hydrograph) and quality (e.g., temperature and chemical composition) are major factors that affect salmon production. In Japan, chum salmon first enter streams when temperatures drop to 15^{o} C and most enter when temperatures are 10-12^{o} C; the peak upstream migration occurs when the temperatures are 7-11^{o} C (Salo 1991). Chum salmon are stimulated to migrate upstream by any increase in stream runoff, e.g., a freshet following a rain storm. Chum salmon deposit their eggs in nests (redds) dug into submerged gravel bars that are porous and have sufficient interstitial water flow to ensure adequate oxygen supply. Chum salmon in Columbia River tributaries build redds in clean gravel of intermediate size: a low proportions of silt and sand (6%) and a low proportion of large cobbles, i.e., only 13% of the substrate was more than 15 cm in diameter (Burner 1951). When the percentage of fines and sand is 22% or more in redds -- the survival of chum salmon eggs was found to be less than 50% (Rukhlov 1969).

Chum salmon eggs are laid in a cone shaped hollow in the gravel about 20-40 cm deep, with a porous layer of stones around the bottom portion (Salo 1991). Based on survival of incubating eggs to emergence, Bruya (1981) concluded that spawning gravel depth should be a minimum of 30 cm, and egg deposition at depths of 40 cm is optimal. High egg mortality and premature emergence of fry occurs in redds less than 20 cm in depth.

Observations at over 1,000 redds in Washington State, indicated that 80% of the chum salmon spawned at velocities of 21.3-83.8 cm/s (mean= 50.3 cm/s) and at depths of 13.4-49.7 cm, with a mean 27.1 cm (Johnson et al. 1971). In Japanese streams, autumn run chum salmon select velocities of 10-20 cm/s and depths of 20 to 110 cm for spawning (Sano and Nagasawa 1958).

Limiting Factors for Chum Salmon in the Lower Columbia River

The cumulative effects analysis of the NOAA Fisheries FCRPS Biological Opinion (NMFS 2008, Section 8.9) summarizes the key limiting factors for Columbia River Chum salmon. The following list of factors is ranked from most limiting to least:

1. Mainstem Hydropower impacts are significant, especially on the Gorge populations;
2. Estuary habitat degradation is an important limiting factor for all chum populations – refer to NMFS (2006);
3. Reduced tributary stream habitat function and wide-spread watershed degradation;
4. Predation impacts (birds, fish and mammals) are unknown and probably vary by location;
5. Effects of reduced marine derived nutrients (salmon carcasses) in chum salmon spawning areas is unknown; but assumed to be less in lower reaches of streams (chum salmon habitat) compared to the more oligotrophic upper stream reaches utilized by other salmonids;
6. Ocean conditions and climate change is assumed to be neutral for the near term, but is uncertain for the long term;
7. Historical and current hatcheries practices have not been a limiting factor; and
8. Currently, direct harvest impacts are negligible and indirect fishery mortality is very low.

The LCR Recovery Plan (LCFRB 2004; Chapter 3) summarizes the limiting factors and ongoing threats to salmon, steelhead, and trout species. Limiting factors are described in relation to the biological needs of the species, and the threats are those activities that lead to the limiting factors. By identifying the threats to recovery, specific recovery strategies and measures can be developed which would guide actions at the subbasin level to mitigate the threats. Limiting factors and threats for salmon and steelhead are described under the broad categories of stream habitat, mainstem and estuary habitat, hydropower, harvest, and hatchery operations. Species averages of currently available habitat (compared to historical) range from a low of 23% for chum to a high of 74% for summer steelhead. Chum salmon have a relatively high potential for benefits from habitat restoration since these percentages describe the scope for potential improvement and the relative scale of habitat degradation for different species and subbasins (Table 3).

Table 3. Current habitat condition for chum salmon by ssubbasin relative to historical conditions. The current condition of stream habitat is expressed as a percentage of historical condition using the Ecosystem Diagnosis and Treatment (EDT) model and properly functioning condition (PFC) as defined by NMFS (1996). {Source LCFRB 2004}

Subbasin	Current Condition (% of Historical Chum Salmon Habitat)	Primary Limiting Factors
Grays/ Chinook	28	A. Loss of off-channel and side channel areas. B. Lower river segments – accumulations of fine sediments. C. Estuary Habitat – loss

Subbasin	Current Condition (% of Historical Chum Salmon Habitat)	Primary Limiting Factors
		of connectivity
Elochoman / Skam	28	A, B, C (as above).
Mill /Abernathy /Germany	28	A, B, C (as above).
L. Cowlitz	14	A, B, C (as above).
U. Cowlitz	--	A, B, C (as above).
Cispus	--	A, B, C (as above).
Tilton	--	A, B, C (as above).
NF Toutle	--	A, B, C (as above).
SF Toutle	--	A, B, C (as above).
Coweeman	--	A, B, C (as above).
Kalama	27	A, B, C (as above).
NF Lewis	--	A, B, C (as above).
EF Lewis	30	A, B, C (as above).
Salmon	0	A, B, C (as above).
Washougal	18	A, B, C (as above).
L. Gorge	41	Hydropower Estuary Habitat
U. Gorge (Wind)	14	Hydropower Estuary Habitat
White Salmon	na	Hydropower Estuary Habitat
Average	***23***	

Note: "—" indicates that an historical population for the species and subbasin did not exist. "na" indicates that an historical population for the species was present in the subbasin, but EDT habitat analyses are not available.

Specific limiting factors for chum salmon include (LCFRB 2004; Chapter 3):

- Chum spawning habitat and coho winter rearing habitat have been particularly impacted by loss of off-channel and side channel areas.
- Historical chum and Chinook spawning sites on lower river segments are especially susceptible to accumulations of fines. Accumulations of fines near the mouths of streams entering the Columbia River upstream of Bonneville Dam have increased since dam construction.
- For species like chum and ocean-type fall Chinook salmon that rear in the estuary for extended periods, a broad range of habitat types in the proper proximities to one another may be necessary to satisfy feeding and refuge requirements within each salinity zone. Additionally, the connectedness of these habitats likely determines whether juvenile salmonids are able to access the full spectrum of habitats they require (Bottom et al. 1998).
- Flow also affects habitat availability for mainstem spawning and rearing stocks. Significant numbers of chum and fall Chinook spawn and rear in the mainstem and side channels of the Columbia downstream from Bonneville Dam. Flow patterns determine the amount of habitat available and can also dewater redds or strand juveniles (NMFS 2000c).

- While ocean conditions are affected by the Pacific Decadal Oscillation (PDO), the phenomenon also influences freshwater environments as well, as precipitation and temperature patterns on land are also affected by the PDO. The most recent PDO shift has been related to increases in production of pink, chum, and sockeye salmon in the North Pacific Ocean (Beamish and Bouillon 1993). Chum salmon have broad, offshore migration patterns that may extend as far as the Gulf of Alaska.

The Status of the Resource (SOTR) Draft Report (CBFWA 2009) summarizes and updates the factors for decline, limiting factors, and threats for recovery for all focal species that were documented in the Subbasin Plans developed through the NPCC subbasin planning effort completed in 2004. These limiting factors, by life stage, for chum salmon in subbasins of the Gorge and LCR-Estuary Provinces are presented in Table 4.

Table 4. Limiting factors for chum salmon and life stage most effected (CBFWA 2009).

Factors for Decline / Limiting Factors / Threats		Cowlitz	Grays	Kalama	Lewis	Wash-ougal	Little White Salmon	Wind
Habitat	Estuary and Nearshore Marine Habitat Degradation	Smolts	Smolts	Smolts	Smolts	Smolts	Smolts	Smolts
	Floodplain Connectivity and function	Fry	Adults	Fry				
	Channel Structure and Complexity	Eggs, adults	Eggs, fry, adults	Fry, adults	Adults	Adults	Fry	Adults
	Riparian Areas and LWD Recruitment	Adults	Adults	Fry, adults	Adults	Adults		
	Stream Flow	Eggs, adults	Fry	Eggs, fry, adults	Eggs, adults	Adults		
	Water Quality	Eggs	Eggs	Eggs, fry, adults	Eggs, adults	Eggs	Fry	All
Hydro	Mainstem CR Hydro power adverse effects						Juveniles	Smolts
Hatchery	Hatchery-Wild Interbreeding	*Adult spawners	Adult spawners					
Predation / Competition / Disease	Pathogens	Eggs, adults		Adults				

* Note: Hatchery-Wild adult spawners interbreeding in the lower Cowlitz River is unlikely since there is no chum hatchery production in that system.

Estuary and nearshore marine habitat degradation – impacting smolts – was the most consistent limiting factor identified in the subbasin plans. The following potential limiting factors were not identified as a problem for chum salmon populations in any of the relevant plans:

- Harvest Mortality: targeted fishery (or incidental catches);
- Hatchery: Competition with hatchery smolts; and
- Predation / Competition: predation by or competition with non-native species.

Limiting Factors in the Oregon Coastal Chum Stratum

ODFW (2009) considers the primary limiting factors and threats to chum salmon in Coastal stratum populations identified in Oregon's Recovery Plan to be:

- alteration of estuarine habitats and ecological conditions affecting juvenile rearing and survival,
- excess fine sediments in spawning gravels,
- and predation on chum fry by hatchery fish in Youngs Bay.

Predation on chum fry by hatchery coho is identified as a potential limiting factor in Young's Bay (ODFW 2009). Hatchery coho programs have been conducted in this area since the early 1900's. In 2007 alone, almost 1.3 million hatchery coho smolts were released into Young's Bay as part of the Select Area Fishery (SAFE) program. The extent to which hatchery releases of coho salmon have affected chum salmon fry has not been evaluated.

Status and Temporal Trends of Chum Population Levels and Distribution

The National Marine Fisheries Service (NMFS) listed Lower Columbia River (LCR) chum salmon as threatened under the Endangered Species Act (ESA) in March 1999 (64 FR 14508, March 25, 1999). The listing was in response to the reduction in abundance from historical levels of more than one-half million returning adults to fewer than 10,000 present-day spawners (Johnson et al. 1997).

The estimated minimum run size for the Columbia River ESU has been relatively stable, although at a very low level, since the run collapsed during the mid-1950s (WDFW/ODFW 2002). Current abundance is probably less than 1% of historical levels, and the ESU has undoubtedly lost some (perhaps much) of its original genetic diversity (NMFS 2000; FCRPS BiOp Appendix C). Average annual natural escapement to index spawning areas was approximately 1,300 fish from 1990 through 1998 (ODFW and WDFW 1999).

Prior to 1997, only two chum salmon populations were recognized as genetically distinct in the Columbia River, although spawning had been documented in many Lower Columbia River tributaries. The first population was in the Grays River (RKm 34), a tributary of the Columbia River, and the second was a group of spawners utilizing the mainstem Columbia River just below Bonneville Dam (RKm 235) adjacent to Ives Island and in Hardy and Hamilton creeks (Johnson et al. 1997). Using additional DNA samples, Small et al. (2004) grouped chum salmon spawning in the mainstem Columbia River and the Washington State tributaries into three groups: the Coastal, the Cascade and the Gorge. The Coastal group comprises those spawning in the Grays River, Skamokawa Creek and the broodstock used at the Sea Resources facility on the Chinook River. The Cascade group comprises those spawning in the Cowlitz (both summer and fall stocks), Kalama, Lewis, and East Fork Lewis rivers, with most thought to support unique populations. The Gorge group comprises those spawning in the mainstem Columbia River from the I-205 Bridge up to Bonneville Dam and those spawning in Hamilton and Hardy creeks.

Oregon Tributaries

All of the historical Oregon side populations in the lower Columbia River are considered functionally extirpated (ODFW 2005; McElhany et al. 2007; ODFW 2009). Based on the TRT analysis, the Oregon portion of the Columbia River chum ESU historically contained 8 populations located within the Coastal, Cascade, and Gorge geographic strata (McElhany et al. 2004). Coastal stratum populations include Young's Bay, Big Creek, Clatskanie, and Scappoose; Cascade stratum populations include Clackamas and Sandy; and the Gorge stratum includes Lower and Upper Gorge populations which occupy both the Oregon and Washington sides of the Columbia and corresponding tributaries.

Washington Tributaries

Bryant (1949) summarized salmon fishery and stream survey data from the 1930's and 1940's and concluded that the major chum populations historically occurred in "Area I" – i.e., in Washington streams from the mouth of the Columbia River to and including the Klickitat River:

> "*Chum salmon seldom go more than 150 to 200 miles from the ocean to spawn. They usually make their first appearance in the Columbia River in October and proceed directly to the lower sections of the tributaries. This species is becoming more important to the commercial fishery as the other species are reduced in abundance and it is to be noted that Area 1 supports larger populations of chum salmon than does all the rest of the Columbia Basin combined.*"[5]

The Lower Columbia/Willamette Technical Recovery Team (TRT) has organized the Columbia River chum ESU into three geographic strata – each comprised of the following Washington-side populations:

1. Coast Stratum (Grays/Chinook, Elochoman, and Mill/Abernathy/Germany);
2. Cascade Stratum (Cowlitz, Kalama, Lewis, Salmon, and Washougal populations; and

[5] Area I in the Bryant (1949) stream surveys was Washington streams from the mouth of the Columbia River to and including the Klickitat River.

3. Gorge Stratum (Lower Gorge, and Upper Gorge tributary populations).

Most populations of the chum ESU are at "very high risk" of extinction (Table 5). The strongest LCR chum populations – Grays/Chinook, Elochoman, and Washougal – are at "high risk" of extinction. Only one lower Gorge population (Ives Area, just below Bonneville Dam) is considered to be in "medium risk" of extinction. The TRT also established population recovery designations for the chum salmon ESU (Table 6).

Table 5. Extinction Risk of Columbia River Chum Salmon Populations[1] as Identified by the Lower Columbia/Willamette TRT (HSRG 2008a).

Populations	Extinction Risk
Coast Stratum	
Grays/Chinook (WA)	High
Elochoman (WA)	High
Mill/Abernathy/Germany (WA)	Very High
Youngs Bay Tribs. (OR)	Very High
Big Creek (OR)	Very High
Clatskanie (OR)	Very High
Scappoose (OR)	Very High
Cascade Stratum	
Cowlitz (WA)	Very High
Kalama (WA)	Very High
Lewis (WA)	Very High
Salmon (WA)	Very High
Washougal (WA)	High
Clackamas (OR)	Very High
Sandy (OR)	Very High
Gorge Stratum	
Lower Gorge Tribs.	Very High/Medium
Upper Gorge Tribs.	Very High/ Very High

[1] From Washington's Lower Columbia River Recovery Plan and McElhany et al. 2007 for Oregon populations

Table 6. Recovery designations of Lower Columbia River and Gorge chum populations (HSRG 2008a).

	Recovery Designations		
Populations	LCR Salmon Recovery Plan (WA)	LCR Salmon Recovery Plan (OR)	TRT
Coast Stratum			
Grays/Chinook (WA)	Primary	Core	Core
Elochoman (WA)	Primary	Core	Core
Mill/Abernathy/Germany (WA)	Primary		
Youngs Bay Tribs. (OR)	Primary	Core	
Big Creek (OR)	Contributing	Core	
Clatskanie (OR)	Contributing		
Scappoose (OR)	Contributing		

Populations	Recovery Designations		
	LCR Salmon Recovery Plan (WA)	LCR Salmon Recovery Plan (OR)	TRT
Cascade Stratum			
Cowlitz (WA)	Contributing	Core	Core
Kalama (WA)	Contributing		
Lewis (WA)	Primary	Core	Core
Salmon (WA)	Stabilizing		
Washougal (WA)	Primary		
Clackamas (OR)	Contributing	Core	Core
Sandy (OR)	Primary		
Gorge Stratum			
Lower Gorge Tribs.	Primary	Core	Core
Upper Gorge Tribs.	Contributing		

Current distribution of chum salmon in the Lower Columbia River is comprised of a few population centers (strongholds):

- Grays/Chinook population (Washington portion of the Coastal stratum),
- Duncan/Hardy/Hamilton/Ives Island population (Washington portion of the Gorge stratum)[6]
- and the Interstate 205 (I-205) spawning aggregation (Woods Landing and Rivershore areas) (Washington portion of the Cascade stratum).

The color coding provided in Table 7 provides a clear visual illustration that all existing chum populations or sub-populations in the lower Columbia River are either at critically low levels (yellow) or on a decreasing trend (orange). The intent of this table is to show the severely depleted condition of all LCR chum populations (and sub-populations) during the most recent years that we have data (i.e., 2002-2007). The underlying numerical data will be presented and discussed in Appendix 2 (refer to Appendix Table 2.1). The relevance of examining the status of geographic sub-populations is that site-specific habitat restoration and supplementation strategies would also be implemented at this relatively fine spatial scale. The current critically low levels of chum populations and sub-populations indicates the need for supplementation strategies to recover these stocks.

The HSRG (2008) concluded that the use of chum conservation hatchery programs should be viewed as an important short-term risk management strategy to preserve the genetic legacy of depressed chum salmon in the Columbia River. The HSRG further stated that hatchery intervention can reduce demographic risk by boosting abundance and additional conservation propagation programs should be promptly initiated within each of the ESU's three geographic strata to reduce this risk. The need for hatchery intervention has been recognized by NOAA Fisheries (2008 FCRPS BiOp).

[6] Ives Area chum are not genetically distinct from mainstem spawners at Multnomah Falls and Horsetail Falls Creek (Oregon portion of the Gorge stratum).

Table 7. Chum salmon abundance trends for Southwest Washington and LCR Tributaries, 2002-2007 (source: Todd Hillson and Julie Henning, WDFW). The color code key is: green: sub-populations that are on an increasing temporal trend; orange: sub-populations that are on a decreasing temporal trend; and yellow: sub-populations with critically low abundance.

River or Tributary	2002	2003	2004	2005	2006	2007
Grays River (Mainstem Grays, WF Grays, and Crazy Johnson Creek)						
Skamokawa Creekand Elochoman River						
Mill, Abernathy and Germany creeks						
Cowlitz and Coweeman rivers						
Kalama River						
Lewis and EF Lewis rivers						
The I-205 Area and nearby tributaries						
Washougal River and Lacamas Creek						
Mainstem- St Cloud						
Mainstem- Multnomah						
Mainstem- Horsetail						
Mainstem- Ives						
Bonneville Tributaries (Duncan, Woodward, Hardy, Hamilton and Greenleaf creeks)						

Key:

Increasing trend	
Decreasing trend	
Critically low	

The stronghold stocks were generally increasing in the early 2000's, but have exhibited decreasing trends in recent years, e.g., Figure 2 (I-205 population) and Figure 3 (Ives Area population). Based on statistically valid population estimates, the mainstem I-205 chum population[7] steadily decreased from about 3,468 in year 2002 to 626 spawners in 2008 (Figure 2).

[7] The I-205 chum salmon spawning area (and corresponding population estimate) consists of the Woods and the Rivershore areas (Todd Hillson, Personal Communication, April 20, 2009).

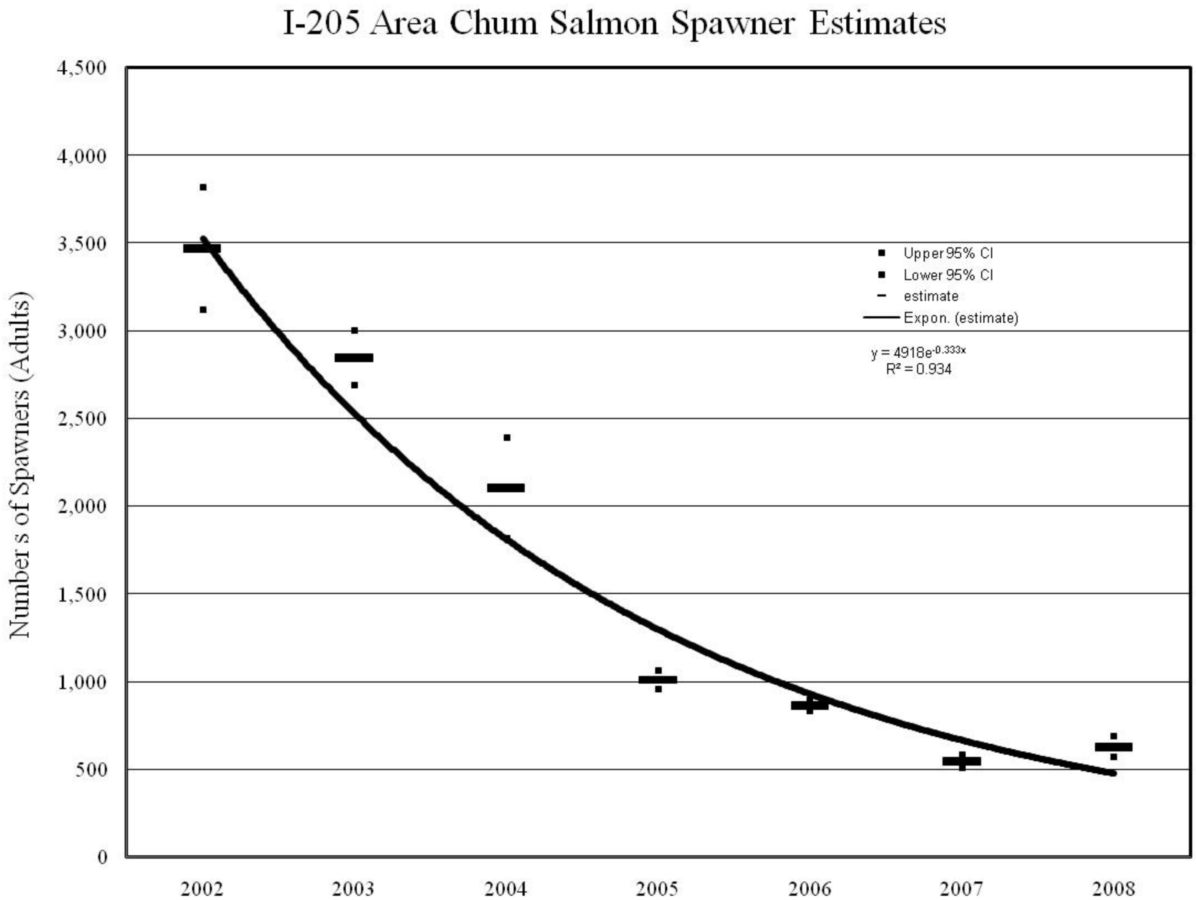


Figure 2. Population estimates of the I-205 (Woods Landing and Rivershore) adult chum population (Source Todd Hillson, WDFW).

The other major spawning region just below Bonneville Dam is the Ives Area; it consists of the mainstem Ives spawning grounds estimate, plus fish destined to spawn in the tributaries (i.e., Hamilton and Hardy creeks). This Ives composite spawning estimate also showed a significant downward trend from 2002 thru 2008 (Figure 3).

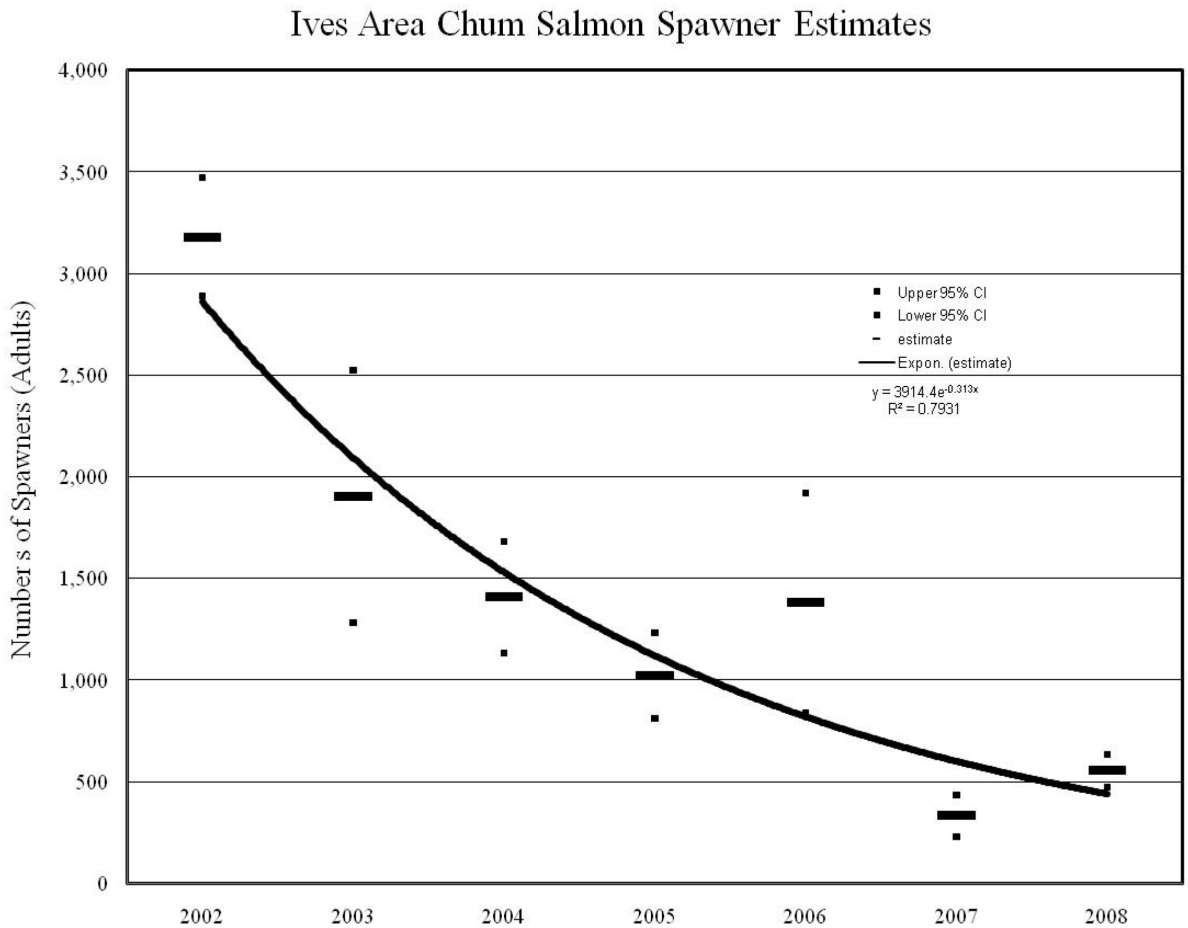


Figure 3. Population estimates of the Ives Area (mainstem Ives spawning grounds plus fish destined to spawn in the nearby tributaries) adult chum population (Source Todd Hillson, WDFW).

The Status of the Resource (SOTR) Draft Report (CBFWA 2009) summarizes and updates the recovery status of populations of chum salmon within the Columbia ESU (Table 8). It clearly stands out that many of the recovery metrics are unknown for Columbia River chum salmon. The current viability for all chum populations is considered to be "very low" – except for the Grays/Chinook population group.

Table 8. Recovery Status of ESA-listed chum (SOTR, CBFWA 2009)

Subbasin / Population	Abundance Threshold	Current Reference Abundance	Major Spawning Areas Occupied	Growth Rate	Recruits per Spawner	Current Viability
LCR and Estuary Province:						
Mill, Abernathy, Germany Ref 900, 901	Unknown	<100	--	--	Unknown	Very Low
Cowlitz Ref 905	Unknown	<300	Unknown	Unknown	Unknown	Very Low
Elochoman / Skamokawa Ref 905	Unknown	<200	Unknown	Unknown	Unknown	Very Low
Grays / Chinook Ref 905	1,120	1,570	--	Unknown	2.50	Moderate
Kalama	Unknown	<100	--	Unknown	Unknown	Very Low
Lewis	Unknown	<100	--	Unknown	Unknown	Very Low
Washougal	Unknown	<100	--	Unknown	Unknown	Very Low
Gorge Province:						
Upper Gorge – Little White Salmon	Unknown	Unknown	--	Unknown	Unknown	Very Low
Upper Gorge – Wind River	1,100	<50	--	Unknown	Unknown	Very Low

Summary of Habitat Impacts

The four previous sections – that discuss causes for decline, biological characteristics, limiting factors, and current status – have presented detailed data on the anthropogenic impacts on LCR habitat that have been significant factors for decline of chum salmon in the Columbia River ESU.

NOAA Fisheries (2008; Table 8.9.2.1-2.) lists estuary and tributary habitat degradation as key limiting factors for Columbia River chum:

> *"Estuary : The estuary is an important habitat for migrating juveniles from Columbia River chum populations. Alterations in attributes of flow and diking have resulted in the loss of emergent marsh, tidal swamp and forested wetlands. These habitats are used extensively by chum juveniles which migrate from their natal areas soon after emergence (Fresh et al. 2005). Estuary limiting factors and recovery actions are addressed in detail as part of a comprehensive regional planning process (NMFS 2006b)."*

> *Habitat: Widespread development and land use activities have severely degraded stream habitats, water quality, and watershed processes affecting anadromous salmonids in most lower Columbia River subbasins, particularly in the low to moderate elevation habitats most often used by chum. The Washington Lower Columbia Recovery and Subbasin Plan (LCFRB 2004) identifies current habitat values, restoration potential, limiting factors, and habitat protection and restoration priorities for chum by reach in all Washington subbasins. Recovery and subbasin plans also identify a suite of beneficial actions for the protection and restoration of tributary subbasin habitats. Similar information is in development for Oregon subbasins."*

It is noteworthy that Craig and Hacker (1940) documented that hydropower, water diversions, and habitat degradation occurred early in the development of the region:

> *"… it must be remembered that under present conditions many miles of spawning streams have been cut off by dams so that they are no longer available to the migratory fish, that irrigation diversions take an enormous toll of the young migrants when they are on their way to the sea, and that pollution and other changed conditions have made many streams less suitable for salmon."*

Likewise, Chapman (1986) observed that logging and habitat impacts had already reduced chum abundance prior to 1915 when commercial fisheries switched from more desirable salmon species to chum salmon.

Hatchery and Artificial Production Impacts

Hatchery fish have had little influence on the wild component of the CR chum salmon ESU (NMFS 2000 FCRPS BiOp Appendix C). NMFS estimates a median population growth rate (lambda) over the base period, for the ESU as a whole, of 1.04 (Tables B-2a and B-2b in McClure et al. 2000b). Because census data are peak counts (and because the precision of those counts decreases markedly during the spawning season as water levels and turbidity rise), NMFS was unable to estimate the risk of absolute extinction for this ESU.

Historically, chum salmon have been less directly impacted by hatchery operations in the Columbia Basin for two reasons:

1. Only a relatively low level of artificial production has occurred for this species in the Columbia Basin – probably because, as a food fish – chum is the least desirable anadromous salmonid species in the Columbia Basin; and
2. Hatchery chum populations are less likely to be affected by domestication given their short-term culture, i.e., released as fry (HSRG 2008a).

Hatchery production of other species in the Lower Columbia River could have contributed to the decline of chum salmon – through competition for food in the tributaries and estuary, predation on chum fry by larger 1-2 year old juveniles of other hatchery salmonid species, and possibly the inter-specific transfer of disease and parasites.

According to the WDFW/ODFW Status Report for 1938-2000 Columbia River Fish Runs and Fisheries (2002), the records of chum salmon returning to Columbia Basin hatcheries are generally not available prior to 1986. The total hatchery returns listed in Table 9 (column 2) are for Sea Resources hatchery (1986-1997), Abernathy Hatchery 1990, and Cowlitz and Elochoman Hatcheries (2000), and Cowlitz Hatchery 1997-present (WDFW/ODFW 2002). Note the returns to Cowlitz, Lewis, and Elochoman hatchery racks are natural origin fish – that are subsequently returned to the river since no hatchery program currently exists in these systems. Grays River hatchery return numbers include fish captured for broodstock in the mainstem and WF Grays River and Crazy Johnson Creek.

Table 9. Returns of adult chum salmon to Lower Columbia River tributary hatcheries (Source: Internet -- WDFW Annual Hatchery Escapement Reports or footnote citation).

Return Year	Total Hatchery Returns*	Cowlitz Salmon + Trout **	Lewis	Elochoman	Grays***
1986	100				
1987	100				
1988	300				
1989	200				
1990	1,200				
1991	200				
1992	900				
1993	3,000				
1994	700				
1995	500				
1996	300	8	0	0	0
1997	<100	8	0	0	10
1998	<100	27	0	0	0
1999	427	17	0	0	410
2000	582	3	1	0	578
2001	254	0	0	0	254
2002	365	2	1	0	362
2003	325	15	0	0	310
2004	316	8	0	0	308
2005	321	13	0	0	308
2006	142	8	2	4	128
2007	125	5	2	0	118
2008	143	5	0	0	138

* Source of total return data: WDFW/ODFW (2002) for the period 1986-98; summation for 1999 to 2008.
** Source of Cowlitz return data: Julie Henning, WDFW – for 2003 to2008.
*** Grays return numbers include broodstock captured in the mainstem Grays, WF Grays, and Crazy Johnson creek in addition to hatchery returns.

The historical influence of hatchery fish in the Grays River basin is small compared to other ESUs (NMFS 2000; FCRPS BiOp Appendix C). Hatchery-cultured chum salmon from Willapa Bay (i.e., Pacific Coast chum salmon ESU) were transplanted into the Chinook River (a tributary to Baker Bay in the Columbia River estuary) during the late 1980s. Initial returns from this transplant were close to a thousand fish per year, but more recent returns have been substantially lower (less than or equal to 20 fish per year during 1997 and 1998). In 1998, WDFW decided that non-native chum salmon should be removed from the system. Consequently, all Willapa

Bay chum salmon returning to the Sea Resources Hatchery during 1999 were destroyed. The Sea Resources and Grays River hatcheries are now used to culture Columbia River chum salmon for reintroduction into the Chinook River. Overall, the abundance of the Grays River population has increased since the mid-1980s, but appears to follow a cyclical pattern. The average population rate of growth was positive in the late 1990s (McClure et al. 2000), but the cyclical trend results in a high variability around the average estimate.

An HGMP has been completed for the Washougal Hatchery Chum Salmon Program (WDFW 2004). The Washougal Hatchery HGMP is a combination of the Duncan Creek reintroduction program and salvage plan for the Washougal and Lower Gorge populations. The goal of the Duncan Creek reintroduction program is to establish a self-sustaining population. This will be accomplished by a combination of juvenile supplementation and releases of wild chum salmon adults into renovated spawning habitat located in Duncan Creek. The goal of the salvage operation is to reduce the extinction risk of Lower Gorge and Washougal chum populations caused by hydropower operations. The approach used here is similar to that being employed for Duncan Creek supplementation. Wild adults will be captured and spawned at the Washougal Hatchery and progeny will be released into tributaries in those years when the Columbia River flow levels place this population at risk by limiting access to spawning areas.. Both programs have monitoring and evaluation components to evaluate the effectiveness of these strategies.

The NOAA Fisheries BiOp (May 21, 2007) Hatchery Proposed Actions recommends reintroduction strategies and implementation of chum supplementation programs:

> ***"Columbia River Chum Salmon***
> *Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation programs for chum salmon in selected Lower Columbia River tributaries below Bonneville Dam."*

Potential Hatchery Impacts in Oregon Tributaries:

Currently chum salmon are considered to be functionally extirpated in Youngs Bay tributaries; however, if chum were reintroduced as proposed by the ODFW (2009) conservation plan the impacts of hatchery-produced coho salmon could become an issue. Hatchery coho programs have been conducted in the Youngs Bay subbasin since the early 1900's. In 2007 alone, almost 1.3 million hatchery coho smolts were released into Young's Bay as part of the Select Area Fishery (SAFE) program. The extent to which hatchery releases of coho salmon have affected chum salmon fry has not been evaluated in the Youngs Bay system.

Hydropower Effects on Chum Salmon

The Columbia River hydropower system – especially Bonneville and The Dalles Dams -- affects chum salmon in three primary ways:

(1) Adult fish passage blockage – of all Pacific salmon and steelhead species, the chum salmon returning adults are least capable of ascending ladders at Columbia River dams;
(2) Spawning and rearing habitat in lower reaches of tributary streams above Bonneville and The Dalles was flooded – reducing production potential of the reduced number of chum salmon spawners able to pass the dams; and
(3) Chum fry disorientation in reservoirs, and increased fish passage mortality through turbines – results in greatly reduced survival and production of chum salmon above Bonneville Dam.

The cumulative impacts of these limiting factors over time have functionally extirpated Chum salmon from all production areas above Bonneville Dam; this happened gradually -- from the time of dam construction (1938) to present. Ongoing threats to salmon from hydropower obstructions and delays include (LCFRB 2004):

- Passage obstructions – blocked spawning and rearing habitat,
- Inadequate passage facilities,
- Poor passage conditions (inappropriate flows), and
- Passage delays and mortality of juveniles and adults.

Additionally, flow level changes below Bonneville Dam associated with power generation can limit access to mainstem and tributary spawning areas in the Ives Island area, dewater existing redds, and affect transit time of juveniles from spawning areas to the Columbia River estuary.

Historical Information on effects of Columbia River Dam Passage Problems on chum salmon

The historical record in the Pacific Northwest shows that dams greater than about 10 m in height, including dams with fish ladders, generally block the upstream migration of adult chum salmon. Furthermore, reservoirs as small as one hectare blocks the downstream migration of juvenile chum salmon. Successful passage of adult spawners, however, has proven successful using conventional ladders at hatcheries -- where the ascent from the river to the hatchery is < 10 m. Most of these hatcheries are located in lower reaches of coastal rivers where tidal influence further decreases the length and rise of the fish passage facility on a daily basis, i.e., at high tides.

Salo (1991) makes the following observations on the swimming and jumping ability of chum salmon:

> "Chum salmon are large, strong swimmers and are capable of swimming in currents of moderate to high velocities. The maximum swimming speed recorded is 3.05 m/s or 67% of the maximum burst speed of 4.6 m/s (Powers and Osborn 1985). They are not leapers and usually are reluctant to enter long-span fish ladders. Thus they are usually found below the first barrier of any significance in a river."

MacKinnen and Brett (1955) described an experiment in which pink and chum salmon fry were released at the upstream end of a 2.4-acre impoundment in British Columbia (Cited by Andrew and Geen 1960). Only 25% of the pink and chum fry moved through the reservoir during a nine-day period when recapture gear was operated at the outlet. Since the fry of these species normally migrate directly to the sea after emerging from the gravel -- the very low recovery suggested a serious loss in the impoundment.

Successful Hatchery ladder designs – show chum salmon capabilities and limitations

Washington Department of Fish and Wildlife (WDFW) operates several successful chum salmon fish hatcheries in the Puget Sound Region that incorporate fish ladders and adult brood stock holding facilities. The Chambers Creek trapping facility (near the city of Tacoma) has two fish ladders on each side of a dam, with holding ponds at the top (Darryl Mills, WDFW Hatchery Manager, Personal Communication). The dam is located near tidewater and creates an impoundment of about 20 acres. The ladder steps are about 10 inches in height with a 6 inch sill. The rise from the creek to the top of the dam, at high tide, ranges from about 6 inches to 6 feet (depending on the strength of the tide). Chum salmon are strong swimmers (e.g., they can swim up an incline over a dam in 2 feet of water) but have very limited jumping ability. The Chambers Creek chum is a late stock that runs in mid-December. The chum salmon move into the facility on a freshet and high tide. Most of the spawners are 3-4 years of age, weigh 4-25 pounds, and are 24-36 inches in length. One interesting observation is that the female chum salmon use the ladder on one side of the dam and the males use the ladder on the opposite side of the dam.

WDFW uses pool and weir fishways for chum salmon hatcheries[8]. The ladder pools are 6 feet wide and 8 feet long, with 9 inch steps. The top log in the ladder is slotted on alternate sides, with 6 inch high by 24 inch wide notches. The minimum required water flow is the amount needed to keep the notch full, the optimum flow is 3 inches over the slot. The number of ladder steps is usually 20 to 25; and the maximum rise of 15-20 feet from the river to the hatchery. Fatigue is a factor for chum salmon; resting pools are needed if the rise is greater than 20 feet.

Bonneville and The Dalles Dams Functionally Blocked Columbia River Chum Runs

The long-term decline in chum salmon runs began when Bonneville Dam (at river mile 146) was completed in 1938 (Figure 4). Since that time, spawning runs of chum salmon in the Columbia River past Bonneville Dam have continued to decline to very low levels; and chum salmon have

[8] The chum salmon ladder design information was obtained from Don Bartlett, a WDFW fisheries engineer (Steve Vigg, Personal Correspondence, October 1996).

been virtually eliminated past river mile 192 because of an effective passage block at The Dalles Dam (second mainstem dam built in 1957) -- see Table 10. This decline of chum salmon occurred even though the mainstem Columbia River Dams were built with adult fish passage facilities[9] and navigation locks that effectively pass four other species of Pacific salmon and steelhead.

Table 10. Counts of adult chum salmon migrating upstream past Bonneville and The Dalles Dams, Columbia River, during 1938-2008 (USACE 2009).

YEAR	5-year Average Count at Fish Ladders	
Interval	Bonneville Dam	The Dalles Dam
1938-1940	1,671.3	--
1941-1945	1,920.8	--
1946-1950	1,622.0	--
1951-1955	1,232.8	--
1956-1960	729.8	41.5
1961-1965	755.2	4.8
1966-1970	331.0	0.2
1971-1975	21.4	0.0
1976-1980	20.2	0.0
1981-1985	45.4	0.2
1986-1990	65.2	0.8
1991-1995	23.4	0.0
1996-2000	30.0	0.0
2001-2005	146.2	6.8
2006-2008	90.3	3.7

The relatively high mean numbers of chum passing Bonneville and The Dalles during 2001-2005 correspond to high redd counts and population abundance estimates of chum below Bonneville Dam during the early 2000's. The 2001-2005 mean value at Bonneville was skewed by an exceptionally high passage number during 2003, i.e., 411 chum salmon. This was the highest chum passage at Bonneville since 1966 when 872 adults passed over the dam.

[9] The Bonneville Dam fishway is comprised of three fish ladders consisting of pools 16 feet in length between transverse weirs, and a 1-foot drop between pools (i.e., a slope of 6.25%). The fish ladders range 1,225 to 1,337 feet in length and are situated on both sides of the river.

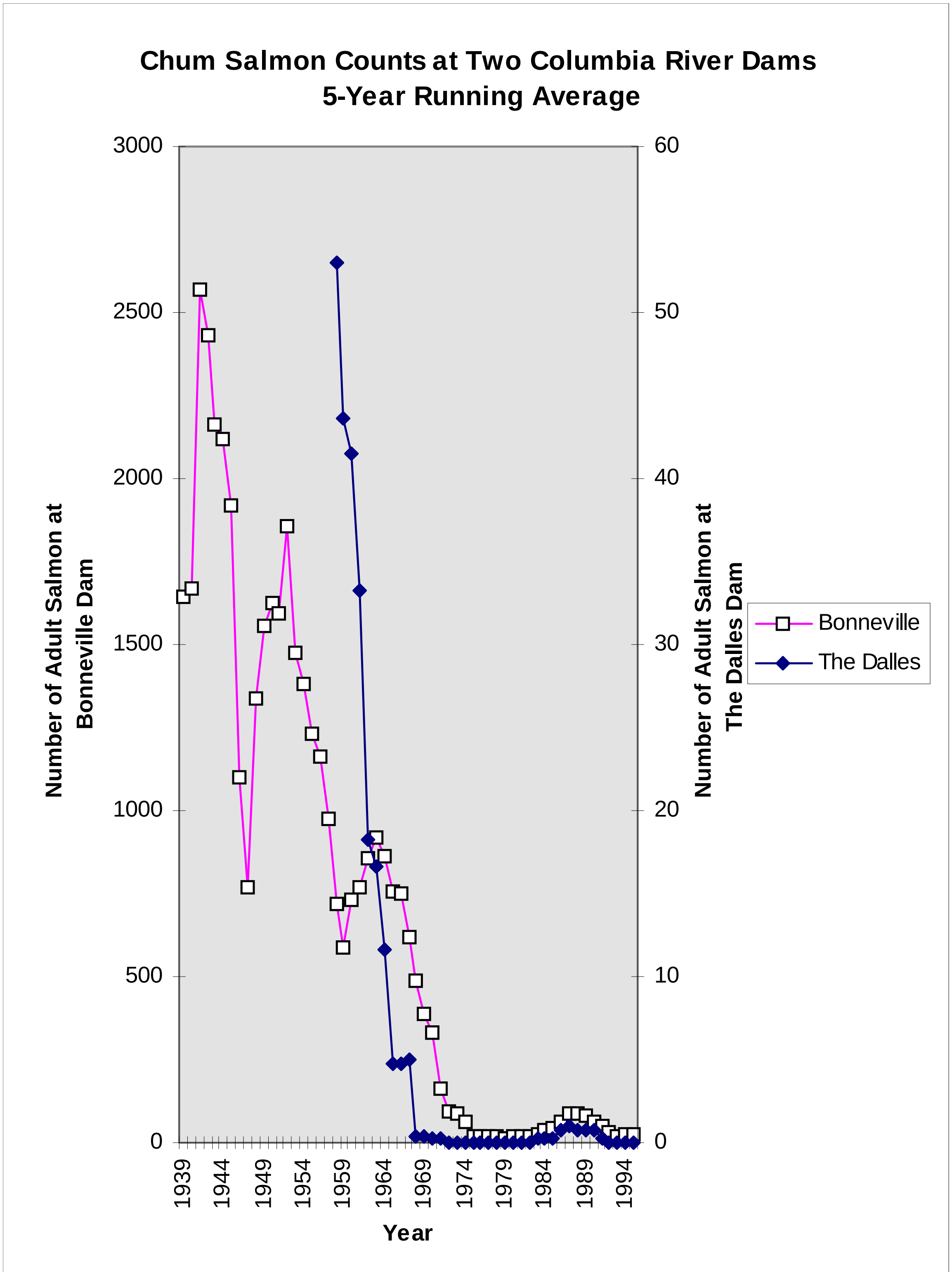


Figure 4. Numbers of chum salmon adults migrating over fish ladders at Bonneville and The Dalles dams, Columbia River, 5-year running averages 1938-1995.

The Columbia River dam passage facilities also enable the upstream migration of American shad (*Alosa sapidissima*) and Pacific lamprey (*Lampetra tridentada*); but effectively blocked adult sturgeon migrations (*Acipenser* spp.).

The maximum pool elevation of Bonneville Reservoir is 82.5 feet above mean sea level (msl) and the power head is 26 feet. Under normal operating conditions, fish ascend a rise of about 51 feet -- the difference between normal operating elevation (74 ft msl) and the tailrace elevation (23 ft msl).

Harvest Impacts

Historically, excessive in-river commercial harvest rates were a major cause of initial chum salmon run size declines prior to 1938. However, it was the construction of Bonneville Dam in 1938 that further depressed the chum spawning runs, and prevented the species from rebounding due to loss of productivity. Productivity was permanently depressed by loss of access to lower tributary spawning areas and rearing areas that were inundated by Bonneville and The Dalles Reservoirs and changes in the seasonal flow patterns below Bonneville Dam.

In-river commercial harvest contributed – as a cumulative effect (along with Hydro and Habitat) to the continued decline of chum salmon from 1938 to the 1950's. In 1942, over 425,000 adult chum salmon were taken in Columbia River commercial fisheries below Bonneville Dam, and it subsequently dropped below 10,000 fish harvested annually after 1955 (WDFW/ODFW 2002). Since the listing of chum salmon under the ESA in 1999[10], catches in the Columbia River sport and commercial fisheries is negligible; and harvest is currently not a limiting factor. Based on all accounts, ocean harvest has never been a limiting factor for Columbia River chum salmon.

Historical Chum Harvest Impacts

Craig and Hacker (1940) estimated that the pre-development (pre-1800) Indian consumption of salmon and steelhead was about 18 million pounds per year (Table 11); i.e., thus, it was comparable to the non-Indian commercial catch of 26 million pounds of salmon and steelhead in 1933. Based on average weight of all species (weighted by abundance) at least 1.2 million salmon were caught annually for consumption by native peoples[11]. Craig and Hacker (1940) explain why the Tribal catch was sustainable and the non-Indian commercial fishery was not:

> *"Even though the primitive Indian catch might have been of some such magnitude as that estimated above, it did not represent as great a proportional strain on the spawning population as its relationship to the present catch would indicate. This is*

[10] Columbia River chum salmon ESU listed as threatened effective May 24, 1999 (64 FR 14507).

[11] The catch number would be higher, if we adjusted it for wastage or use for other purposes; i.e., fish caught but not used for human consumption.

true because it must be remembered that under present conditions many miles of spawning streams have been cut off by dams so that they are no longer available to the migratory fish, that irrigation diversions take an enormous toll of the young migrants when they are on their way to the sea, and that pollution and other changed conditions have made many streams less suitable for salmon."

Table 11. Total annual consumption of anadromous salmonids by Indians in the pre-development period, i.e., 1800 (Craig and Hacker 1940).

Harvest	Reference	Basis
18 Million pounds	Craig and Hacker (1940)	50,000 people eating 1 pound per day
15 Pounds Weighted Average	Chapman (1986)	Literature: Smith (1985); Beiningen (1976); Craig and Hacker (1940); Thompson (1951)
1.2 Million	calculated	Number consumed/ weighted mean weight (all species)

Craig and Hacker (1940) documented dip net catch data from Indian fisheries at Celilo Falls – collected by the Bureau of Fisheries during 1889 to 1892, and 1925 to 1934; chum salmon catches were only recorded for the later time period (Table 12). The total 14-year dip net catch during 1889-1925 was composed of 18.5 percent sockeye, 56.1 percent Chinook, 0.9 percent chum, 7.1 percent coho, and 17.4 percent steelhead.

Table 12. Catches of chum salmon in Indian dip net fisheries at Celilo Falls – collected by the Bureau of Fisheries during 1925 to 1934 (Craig and Hacker 1940, Table 11).

Year	Chum Catch		Total Pounds (all species)
	Pounds	Percent of Total	
1925*	342	0.9	36,927
1926	--	--	238,695
1927	--	--	54,572
1928	4,164	2.9	142,007
1929	8,027	2.0	402,031
1930	6,892	1.1	627,438
1931	31,186	3.7	842,007
1932	--	--	231,194
1933	1,246	0.1	851,630
1934	600	0.1	530,500

* Catches during 1925 were recorded only for the Washington side landings.

Craig and Hacker (1940) noted:

> *"The amounts of chum and silver salmon caught by the dip nets are small because the majority of the fish of these two species spawn in the tributaries below Celilo Falls and enter the river so late that most of the Indians have left the fishing grounds before the small part of the run which does reach Celilo Falls arrives there."*

Based on historical data, Chapman (1986) concluded that spring and summer Chinook made up virtually all the commercial harvest in the early-development period of about 1881-1885. The shifts in canned salmon products documented by Craig and Hacker (1940) shows that fisheries targeted and over-exploited the most favored species and stocks then changed over to the next most desirable and profitable in the following sequence (Table 13): (1) summer Chinook, (2) sockeye, (3) spring Chinook, (4) steelhead, and (5) coho. The least desirable salmon for food fish were fall Chinook salmon and chum salmon.

Chapman (1986) summarized the timing of peak Columbia River chum harvest:

> *"The peak 5 years for chum salmon catches were 1915-1919, reflecting a shift in interest from other heavily fished runs to less desirable species. The mean peak-period catch of 1.99 x 106 kg of chum salmon translates to about 359,000 fish annually."*

It is interesting that the highest peak catches of chum salmon on record for the LCR commercial fisheries actually occurred in 1941 (340,100) and 1942 (425,400) – just 3-4 years after Bonneville Dam was completed (WDFW/ODFW 2002). One could speculate that the passage delay or blockage created by Bonneville made the chum salmon stocks and production previously originating above Bonneville more vulnerable to fisheries below the dam.

Bryant (1949) summarized salmon fishery and stream survey data from the 1930's and 1940's; he also observed that the focus of commercial fisheries had changed to chum salmon during that time because of the depletion of the more desirable salmonid species:

> *"This species is becoming more important to the commercial fishery as the other species are reduced in abundance and it is to be noted that Area 1 supports larger populations of chum salmon than does all the rest of the Columbia Basin combined."*[12]

[12] Area I in the Bryant (1949) stream surveys was Washington streams from the mouth of the Columbia River to and including the Klickitat River.

Table 13. Estimates of the pre-development level of total abundance of anadromous salmon and steelhead adults (Chapman 1986).

Species (stock)	Period for Peak Harvest (sequence)	Peak Catch[13] (Million)	Probable Actual (Optimum) Harvest Rate	Peak Runs - Lower (Millions)	Peak Runs - Upper (Millions)	Relative Abundance (Percent)
Sockeye Salmon	1883-1889 (2)	1.915	85 (73)	2.253	2.623	29.5 - 30.2
Summer Chinook	1881-1885 (1)	1.700	85 (68)	2.000	2.500	26.8 - 28.1
Spring Chinook	1890-1895 (3)	0.400	80 (68)	0.500	0.588	6.6 - 6.7
Fall Chinook	1915-1919 (6)	1.100	88 (88)	1.250	1.250	14.1-16.8
Coho Salmon	1894-1898 (5)	0.476	85 (77)	0.560	0.618	7.0 - 7.5
Chum Salmon	1915-1919 (6)	0.359	80 (48)	0.449	0.748	6.0 - 6.8
Steelhead	1892-1896 (4)	0.382	85 (69)	0.449	0.554	6.0 - 6.2
Total	1881-1919	--	--	7.461	8.881	100%

The above quotation is also noteworthy because it documents that the Washington-side tributaries of the Columbia River – from the Pacific Ocean confluence to the Klickitat River – have historically been the major chum production area. This is still true today since most if not all of the Oregon-side populations have been extirpated (ODFW 2009).

Beginning in the mid-1950s, commercial catches declined drastically and in later years rarely exceeded 2,000 per year (NMFS FCRPS BiOp 2000; Appendix C).

Current Chum Harvest Impacts

Lower Columbia River fisheries management is coordinated with a number of ongoing Federal, Tribal and State plans and processes (Vigg and Dennis, editors 2009):

- The Fisheries Management and Evaluation Plan (FMEP);
- Hatchery Scientific Review Group (HSRG) review for the Lower Columbia Region;
- Hatchery and Genetic Management Plans (HGMPs);
- The Lower Columbia River Conservation and Sustainable Fisheries Management

[13] To calculate catch numbers from canning records in weight, Chapman (1986) used the mean weight of Columbia River salmon species in the late 1800's (from Smith 1895): 10.45 kg for summer Chinook, 3.18 kg for coho, 2.25 kg for sockeye salmon, and 4.68 kg for steelhead, 5.54 kg for chum salmon.

Plan;
- The Washington Statewide Steelhead Management Plan (SSMP); and
- The 2008-2017 *US v. Oregon* Fisheries Management Plan.

Chum salmon are present in the LCR and its tributaries from October through January. Columbia River fisheries that potentially cause incidental catches of chum salmon are late fall commercial fisheries targeting late stock hatchery coho and sturgeon. Through the *US v. Oregon* Compact process, chum impacts are limited by gear mesh size restrictions in sturgeon fisheries and by curtailing coho fisheries by November before significant numbers of chum are present.

Oregon closed targeted chum fisheries in 1992, and most Washington tributaries have been closed to chum salmon fishing since 1995. Annual catch, as reported incidental take in the late fall mainstem Columbia River fishery, was less than 50 fish from 1994-2000 (NMFS FCRPS BiOp 2000). Incidental catch of chum salmon in the mainstem lower Columbia River has remained low during 2002-2007 with ESA impact rates of 5% and a target rate of 2%.

The following data from the LCR FMEP (Vigg and Dennis, editors 2009) shows that the incidental chum catch reported from mainstem commercial fishery landings has remained low (Table 14). Further regulatory restrictions have been placed on tributary fisheries; seasons were specifically closed for chum salmon retention in the Cowlitz and Lewis Rivers through the North of Falcon Process in 2008.

Table 14. Reported incidental catch (landings) of lower Columbia River chum salmon populations in mainstem commercial salmon fisheries (Todd Hillson (WDFW) and Joe Hymer(PSMFC)).

Year	*Incidental Chum Catch – Commercial Landings*
2002	***12***
2003	***6***
2004	***90***
2005	***10***
2006	***3***
2007	***38***

In 1996, Congress passed the Sustainable Fisheries Act, which revised the Magnuson Act. The Pacific Fishery Management Council (PFMC) is one of eight regional fishery management councils established by the Magnuson Act. The PFMC is responsible for fisheries off the coasts of California, Oregon, and Washington. Sockeye, chum, and steelhead are rarely caught in the ocean fisheries under the jurisdiction of PFMC. Columbia River chum salmon are also rarely taken off Alaska (Table 15).

Table 15. Approximate annual exploitation rates (percent of total population harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls; data represent the 2001-2003 fishing period (LCFRB 2004).

Fisheries	Chum Salmon Exploitation Rate
AK/ Canada Ocean	0%
West Coast Ocean	0%
Col River Commercial	1.5%
Col River Sport	0%
Trib. Sport	1.0%
Wild Total	2.5%
Hatchery Total	2.5%
Historic Highs	60%

Even though no fisheries target chum salmon, fishing activities result in the following potential threats:

- Incidental catch in sport and commercial fisheries, and
- Poaching.

Chum Catch in Oregon Fisheries

Youngs Bay is the centerpiece of the Select Area Fisheries Evaluation (SAFE) terminal fisheries program managed by ODFW and WDFW. According to ODFW's 2005 Native Fish Status Report (ODFW 2005) and McElhany et al. (2007) chum salmon are now functionally extinct in Young's Bay. A few adult chum salmon still appear to enter Young's Bay and have been incidentally caught in terminal commercial fisheries in recent years (Kostow 1995; North et al. 2006); however, observations of chum in Oregon tributaries are currently rare. One adult chum was observed in the South Fork Klaskanine during a chum survey conducted in 2000 (Muldoon et al. 2001), and another one was observed during ODFW random coho surveys conducted between 2002 and 2007 (ODFW 2009). It is possible that adult chum salmon that have been recently observed within the Youngs Bay subbasin were strays from the Grays River.

The HSRG (2008) noted a potential fisheries management conflict relative to the "Primary" designation of the (extirpated) Youngs Bay chum populations:

> *"The HSRG reviewed options for chum conservation in the lower Columbia River in the context of conservation goals for other salmon and steelhead ESUs as well as the objectives of fisheries managers for Chinook and coho harvest. Based on this broader context, the HSRG notes that conservation goals for the chum population in the Youngs Bay tributaries (as a Primary population) may be in conflict with conservation and harvest goals for coho salmon in this area. Timing of intensive gill-net fisheries in Youngs Bay to fully harvest hatchery-origin coho overlaps with the return of adult chum salmon. Furthermore, the release of large numbers of juvenile Chinook and coho salmon from net pens in this area may also cause excessive predation on migrant chum fry. Other chum populations in the Coast stratum are more likely to achieve the status of a Primary population in a manner that is compatible with the managers' goals for Chinook and coho."*

ESA Listings

The National Marine Fisheries Service (NMFS) listed Lower Columbia River (LCR) chum salmon as threatened under the Endangered Species Act (ESA) in March 1999 (64 FR 14508, March 25, 1999). The listing was in response to the reduction in abundance from historical levels of more than one-half million returning adults to fewer than 10,000 present-day spawners (Johnson et al. 1997). Harvest, habitat degradation, changes in flow regimes, riverbed movement and heavy siltation has been largely responsible for this decline (Johnson et al. 1997).

WDFW Restoration Efforts

Response to the federal ESA listing has been primarily through direct-recovery actions: reducing harvest, hatchery supplementation using local broodstock for populations at catastrophic risk, habitat restoration (including construction of spawning channels) and flow agreements to protect spawning and rearing areas. Both state and federal agencies have built controlled spawning areas. In 1998, the Washington Department of Fish and Wildlife (WDFW) began a chum salmon supplementation program using native stock on the Grays River. This program has continued through 2007, but is currently unfunded. In 2001, WDFW and the Pacific States Marine Fisheries Commission (PSMFC) received Bonneville Power Administration (BPA) funding (project # 2001-053-00) to construct/restore spawning channels in Duncan Creek and evaluate two reintroduction strategies – recolonization of the channels through release of adult spawners into the channels, and direct plants of hatchery reared fed-fry released at the mouth of Duncan Creek and natural recolonization via straying. This project is on going; however, budget reductions in Federal Fiscal Year (FFY) 08 eliminated the hatchery release component of the project. Results from the Duncan Creek project are intended to help guide reintroduction strategies in other Lower Columbia areas.

Recovery Planning

In Washington State, the Lower Columbia Fish Recovery Board (LCFRB) was established to develop and implement a recovery plan for ESA listed salmon and steelhead populations. In December 2004, the State of Washington submitted the LCFRB Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan to the National Oceanic and Atmospheric Administration (NOAA)–Fisheries to address the recovery of salmon and steelhead populations in this domain (LCFRB 2004). The goal of this plan is to "recover Washington lower Columbia salmon, steelhead, and bull trout to healthy, harvestable levels that will sustain productive sport, commercial, and tribal fisheries through the restoration and protection of ecosystems upon which they depend and implementation of supportive hatchery and harvest practices; and sustain and enhance the health of other native fish and wildlife species in the lower Columbia through protection of the ecosystems upon which they depend, control of non-native species, and the restoration of balanced predator/prey relationships" (LCRFB 2004).

The LCFRB plan (2004) focuses on recovery goals and strategies for salmon and steelhead populations in Washington LCR subbasins; however, because LCR salmon and steelhead ESUs include both Washington and Oregon populations, the plan included Oregon populations in the development of a recovery scenario. Utilizing the population structure and recommendations provided by the Lower Columbia/Willamette TRT, populations are designated as 1) primary – those to be restored to a high viability level, 2) contributing – those to be restored to a medium viability level , or 3) stabilizing – those to be maintained at current viability levels (LCFRB 2004). ODFW is currently working on recovery plan for Oregon salmon and steelhead populations. The WDFW worked with LCFRB staff in the development of the Recovery Plan and has endorsed its use as the primary strategy for recovery efforts in Washington LCR subbasins. Guided by population recovery designations, the LCFRB plan outlined recovery goals based on Viable Salmonid Population (VSP) parameters (McElhany et al. 2000) for LCR salmon and steelhead populations. Abundance goals for LCR chum salmon are presented in Table 15.

Table 15: Recovery Goals for Lower Columbia River Chum Salmon Populations – from LCFRB Recovery Plan (2004).

Population	Scenario contrib.	Viability Current	Viability Goal	Abundance Current	Abundance Viable	Abundance Potential	Abundance Goal
Coast							
Grays/Chinook	Primary	Low+	High+	960	4,300	7,800	6,000
Eloch/Skam	Primary	Low	High	<150	1,100	8,200	1,100
Mill/Ab/Germ	Primary	V Low	High	<150	1,100	3,000	1,100
Youngs (OR)	Primary	na	High	na	1,100	2,200	na
Big Creek (OR)	Contributing	na	Low	na	1,100	2,200	na
Clatskanie (OR)	Contributing	na	Med	na	1,100	2,200	na
Scappoose (OR)	Contributing	na	Low	na	1,100	2,200	na
Cascade							
Cowlitz	Contributing	V Low	Med	<150	1,100	135,700	600
Kalama	Contributing	V Low	Low	<150	1,100	12,200	150
Lewis	Primary	V Low	High	<150	1,100	71,000	1,100
Salmon	Stabilizing	V Low	V Low	<150	1,100	4,200	75
Washougal	Primary	Low	High+	<150	1,100	9,400	5,200
Clackamas (OR)	Contributing	na	Med	na	1,100	2,200	na
Sandy (OR)	Primary	na	High	na	1,100	2,200	na
Gorge							
Lower Gorge	Primary	Med+	High+	542	2,600	3,100	2,800
Upper Gorge	Contributing	V Low	Med	<100	1,100	5,900	600

IMPLEMENTATION PLAN

Review of Chum Salmon Project Implementation

Summary of Completed Actions:

Fish manager's response to the federal Endangered Species Act (ESA) listing has been primarily through direct-recovery actions: reducing harvest, promoting hatchery supplementation using local broodstock for populations at catastrophic risk, increasing habitat restoration (including construction of spawning channels) and flow agreements to protect spawning and rearing areas. Both state and federal agencies have supported the development of controlled spawning areas to restore depleted chum populations. The following points summarize the information provided by three important ESA documents:

a) The initial NMFS chum salmon status review (Johnson et al. 1997) did not provide an in-depth review of limiting factors and causes for decline of LCR chum salmon; it provided more detailed information on Puget Sound populations.

b) The Lower Columbia River Recovery Plan (LCFRB 2004) includes a detailed summary of limiting factors by subbasin, and proposed actions to address these factors. The LCFRB has also developed methodology for ranking proposed habitat projects based on biological effectiveness (see Appendix x for details). This information and methodology will be incorporated into our comprehensive strategy for chum salmon reintroduction/supplementation – to be developed during the first year of the project.

c) The cumulative effects analysis of the NOAA Fisheries FCRPS Biological Opinion (NMFS 2008, Section 8.9) summarizes the key limiting factors for Columbia River Chum salmon.

Summary of Ongoing Actions:

WDFW has conducted a chum salmon supplementation program in the Grays River basin since 1998 using native broodstock and releasing fed-fry to maintain an at-risk stock. This program has continued through 2007 – with various funding sources – but is currently unfunded. WDFW initiated this program to prevent possible near-complete loss of brood years due to the highly dynamic and unpredictable nature of the basin and the risk of losing the Gorley Springs spawning area, the only protected off-channel spawning area in the basin. The Gorley Springs area was in fact lost in the winter of 1999 to an avulsion that destroyed the dyke protecting it. Annual releases of fed-fry have varied between 400K (initially) and 120K (more recent) in response to increased adult returns.

The Grays River program was modeled on, and developed under, the guiding standards of successful chum salmon supplementation programs implemented in the Puget Sound and Hood Cannel (WDFW and PNPTT 2000; Ames and Adicks 2003; Johnson et al. 2003; Schroder and Ames 2004).

In 2001, WDFW and the Pacific States Marine Fisheries Commission (PSMFC) received BPA funding (project # 2001-053-00) to construct/restore spawning channels in Duncan Creek and evaluate two reintroduction strategies – (1) recolonization of the channels through release of adult spawners into the channels, and (2) direct plants of hatchery reared fed-fry released at the mouth of Duncan Creek– and natural recolonization through straying. This project is ongoing; however, budget reductions in FFY08 eliminated the hatchery release component of the project. Results from this project are intended to help guide reintroduction strategies in other Lower Columbia River areas.

Beginning in April 2009, WDFW is working – in conjunction with LCFRB, LCREP and other partners – on implementing a new FCRPS BiOp Estuary Memorandum of Agreement (MOA) with BPA and the Corps. WDFW will be the lead for identifying and sponsoring new habitat restoration projects in the LCR below Bonneville Dam. As this process develops, WDFW will integrate high priority estuary habitat restoration projects – focused on ocean type salmon – with the comprehensive Chum Salmon Enhancement Project.

How this Proposed work will Integrate New Actions:

In BPA's submittal letter to the Council, it summarized new actions targeted for 2009:

- The initial contract is slated to start May 1, 2009[14] with a BPA FFY09 funding commitment of $265,082;
- This will provide for planning stages of the subsequent comprehensive project;
- It will initiate the NPCC Three-Step process for the Grays River chum salmon supplementation program; and
- It will also provide habitat work to remove the canary reed grass from the Hamilton Springs spawning channel graveled/watered areas before the 2009 chum salmon spawning season."

Coordination of Chum Restoration with Oregon

Washington Department of Fish & Wildlife Region 5 managers and staff have had ongoing communications with Chris Knutsen, Oregon Department of Fish & Wildlife (ODFW), lead on Coastal and Lower Columbia River chum salmon recovery efforts[15]. ODFW no longer conducts any Columbia River or Columbia River tributary surveys that specifically target chum salmon. However, late season salmon surveys, conducted by ODFW staff based in Corvallis, incidentally observe chum (e.g., late coho surveys in the Big Creek drainage).

ODFW has developed a conceptual Recovery Strategy – focused initially on the Oregon coastal strata, that includes Youngs Bay, Big Creek and Clatskanie River (ODFW 2009; Appendix 4):

> *"Oregon has decided to focus our recovery strategy in the Oregon portion of the Coastal stratum. We believe the basins in the Coastal stratum have been altered to a lesser extent by human development than basins in the other strata, and provide the best opportunity with fewer constraints to re-establish self-sustaining chum populations. As a result, this strategy document focuses on recovery efforts for the Coastal geographic stratum only. Oregon intends to use results from this program to inform decision-making regarding recovery of chum salmon into the Cascade and Gorge geographic strata in the future."*

We discussed the ODFW conceptual recovery strategy with Chris Knutsen (Personal Correspondence, May 5, 2009) – summarized below:

a) Identify a chum salmon donor population that could be used as broodstock for a supplementation program – probably from the Grays River, Washington stock;
b) Develop a locally adapted chum salmon broodstock, probably at Big Creek Hatchery;
c) Begin re-introducing chum salmon to selected coastal stratum streams as a first priority:
    i) recovery strategy will include one coastal stratum population to be monitored for re-colonization, and

[14] The start date has been revised by Tracy Houser, BPA COTR, to July 1, 2009.
[15] Chris Knutsen, District Fish Biologist, ODFW - North Coast Watershed District, 4907 Third Street, Tillamook, Oregon 97141; Phone: 503-842-2741.

ii) one population targeted for reintroduction.

d) Begin re-introducing chum salmon to selected lower Columbia streams (as a secondary priority) at a later time;

e) Monitor and evaluate to adaptively manage the chum re-introduction and the supplementation program.

Currently this Recovery Strategy for chum salmon restoration in Oregon tributaries is at a conceptual stage and funding is not available for implementation. ODFW plans to coordinate with WDFW at a more substantive level when funding is secured to implement the program. At that time ODFW and WDFW would develop an Inter-Agency co-management agreement to initiate the chum supplementation program (Chris Knutsen, ODFW, Personal Correspondence, May 6, 2008).

Given the information presented above, it is apparent that extensive coordination with ODFW on the WDFW LCR Chum Project is premature at this time – since chum are functionally extirpated from Oregon tributaries and ODFW is not currently implementing chum monitoring or restoration projects in the Lower Columbia River. When ODFW decides to begin implementation of its restoration strategy (ODFW 2009) and acquires funding, then WDFW will assist as requested, including the evaluation of the Grays River population as a possible donor stock.

Benefits of the WDFW reintroduction strategy – combination of habitat restoration and supplementation – for wild fish restoration

Historically, hatchery fish have had little influence on the wild component of the CR chum salmon ESU (NMFS 2000 FCRPS BiOp Appendix C). The HSRG (2008a; Appendix 3) concluded that the use of chum conservation hatchery programs should be viewed as an important short-term risk management strategy to preserve the genetic legacy of depressed chum salmon in the Columbia River. It supported this conclusion with the following points:

- Hatchery intervention can reduce demographic risk by boosting abundance;
- Additional conservation propagation programs should be promptly initiated within each of the ESU's three geographic strata to reduce this risk;
- These programs should last up to three generations;
- Broodstock should be selected from the target population, or in the case of reintroductions, from the most suitable available population; and
- The need for hatchery intervention has been also recognized by others and funding appears to be available to pursue chum hatchery programs following more detailed planning.

Chum salmon hatchery programs have been associated with increased abundance of natural chum populations, most notably summer chum salmon in Puget Sound. Hatchery chum salmon populations are less likely to be affected by domestication given their short-term culture. Recently, there have been two hatchery conservation programs for chum salmon in the Columbia

Basin, Grays River/Chinook River (WA) in the Coast stratum (1998-2008), and Duncan Creek (WA) in the Gorge stratum (2001-2007), both are currently unfunded. The HSRG recommends the continuation of the current chum conservation programs in Grays River and Duncan Creek.

Small et al. (2009 unpublished manuscript) discuss the reduced domestication benefits supplementation programs relative to other potential issues such as genetic diversity and effective population size:

> *"Incorporating more spawners adapted to natural conditions into hatchery brood stocks is hypothesized to lessen overall domestication selection in the population in comparison to using hatchery-origin brood stock (Lynch and O'Hely 2001; Ford 2002; Araki et al. 2007). However, hatchery programs may still pose risks to genetic diversity and effective population size (N_e) if hatchery fish arise from small brood stocks and numerically overwhelm wild-origin fish on natural spawning grounds. This may increase overall variance in family sizes in the total population (Ryman-Laikre effects, Ryman and Laikre (1991), and decrease genetic diversity and N_e, the key parameters determining the adaptive potential of a population (Hedrick 2005)."*

WDFW will monitor the genetic attributes discussed above – as part of the stock assessment M&E component.

The HSRG (2008) further recommends that fishery managers implement the following actions to protect wild populations, while implementing the supplementation strategies:

1. Promptly plan, develop and implement at least one additional chum salmon reintroduction or conservation program in both the Coast and Gorge strata and at least two programs in the Cascade stratum.
2. Programs should include a sunset clause that would suspend the hatchery program after three generations, unless evidence suggests suspending releases earlier or extending the program beyond three generations would benefit the populations.
3. All hatchery-origin fish should be marked and the proportion of hatchery fish on the spawning grounds monitored.
4. Investigate ecological variables that might be constraining the viability of the chum salmon in the Columbia River and develop one or more plausible hypothesis.
5. Based on results of the initial propagation programs and the plausible hypotheses about the cause of decline, consider additional reintroduction programs to achieve, at a minimum, preservation of the genetic identity and reduction of demographic extinction risks.

NOAA Fisheries (2007) summarized Action Agency-funded hatchery programs that are the subject of ESA Program-level Consultation, including the Duncan Creek Chum programs (Table 16). The overall benefit of chum supplementation is to prevent extinction and preserving genetic resources of distinct populations in the LCR. VSP parameters positively affected by these supplementation programs are:

- Abundance (A)
- Spatial Structure (SS)
- Diversity (D).

Table 16. Past and future benefits summary – including VSP parameters positively affected – for the Duncan Creek chum supplementation program and future federally funded pilot supplementation programs for chum salmon in selected Lower Columbia River tributaries (NOAA Fisheries 2007).

PAST ACTIONS (2000 - 2006) Benefits Summary								
Population	Action Agency Hatchery Action		VSP Parameters Positively Affected				Benefit accrued to natural population during (D) or after (A) BiOp period	Comments
			A	P	SS	D		
Lower Columbia Gorge Tributaries	BPA funded the program to re-introduce Columbia River chum salmon in Duncan Creek		X		X	X	**H** benefit for preventing extinction and preserving genetic resources of the population. (BPA)	No action in the Coarse Screen for this ongoing program.

FUTURE ACTIONS Benefits Summary								
Population	Action Agency Proposed Hatchery Action	Continuation of Ongoing Action or New Action	VSP Parameters Positively Affected				Benefit accrued to natural population during (D) or after (A) BiOp period	Comments
			A	P	SS	D		
Lower Columbia Gorge Tributaries	Fund the program to re-introduce Columbia River chum salmon in Duncan Creek as long as NOAA Fisheries considers it beneficial to recovery and necessary to reduce extinction risk of the target population.	**Continued**	X		X	X	**H** benefit for preventing extinction and preserving genetic resources of the population **during** and **after** the period of the BiOp. (BPA)	No action in the Coarse Screen for this ongoing program.
ESU-wide	Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River Tributaries below Bonneville Dam.	**New**	X		X	X	**H** benefit for preventing extinction and preserving genetic resources of the populations **during** and **after** the period of the BiOp. (BPA)	No action in the Coarse Screen for this new proposal.

WDFW generally agrees with Oregon's (2009) chum recovery strategy – that is based on HSRG recommendations regarding conservation hatchery supplementation, and further recognizes that successful recovery of chum salmon is highly unlikely unless the factors for their decline are addressed concurrently, and as an integrated component of hatchery supplementation. As such, the artificial propagation component of the chum salmon recovery strategy is viewed as a relatively short-term measure (3 generations) aimed at ensuring the development of sustainable wild populations, while key limiting factors (*i.e.* Habitat, Harvest, Hydro) continue to be addressed over a much longer time period.

Phased Implementation Approach

WDFW identified a phased approach for the implementation of this proposal:

Phase 1: Development of an integrated program for chum salmon habitat restoration and supplementation/ reintroduction in FFY 2009;

Phase 2: Full implementation of the program in FFY 2010.

In this section, we describe the Phase 1 -- Program development in FFY 2009 -- within the framework of five components, and deliverables within each component:

1) An assessment of priority habitat restoration and/or chum channel sites;
    a. Deliverables:
        i. Prioritized list of potential habitat restoration projets and chum salmon spawning channel sites in Washington LCR tributaries describing the benefits of each.
2) An updated stock status review of LCR chum salmon population structure and abundance necessary to prioritize restoration and guide future implementation of supplementation/reintroduction;
    a. Deliverables:
        i. Processing and analysis of otolith and DNA samples identified in Table 5 (of original proposal).
        ii. Updated genetic analysis of LCR chum salmon population structure.
        iii. Update of WDFW's Salmonid Stock Inventory database (SaSI) with current population structure and updated abundance data.
3) Adaptive management of existing supplementation programs;
    a. Deliverables:
        i. An Adaptive management plan to be integrated with the M&E Plan (#5 below).
4) Development of a stepwise enhancement program that utilizes supplementation/reintroduction to rebuild LCR chum populations
    a. Deliverables: FFY 2009 - Maintain Grays River Supplementation Program
        i. Up to 200,000 chum fry released from the Grays River Hatchery in spring 2010, thermally marked for identification upon recovery via otoliths from adult carcasses.
        ii. An NPCC Three-Step review for the Grays River Supplementation Program.
        iii. Development of a supplementation/reintroduction strategy for LCR chum salmon to link with habitat restoration and chum channel project implementation. Including:

1. Identification of priority populations for supplementation/reintroduction.
2. Identification of supplementation/reintroduction method(s) suitable for priority populations.

b. Develop strategy for future supplementation/reintroduction programs.

i. In FFY 2009, we propose to develop a strategy that incorporates population recovery designations (Table 2, of original proposal), updated genetic and abundance information and potential habitat restoration/chum channel projects in identifying:

1. priority populations for supplementation/reintroduction,
2. preferred methods of supplementation/reintroduction for these populations, and
3. the genetic stock source (donor stock) for each, including:
    a. stock source for supplementation/reintroduction of priority populations.

5) Development of a comprehensive program to monitor LCR chum salmon populations and evaluate the effectiveness of habitat restoration and supplementation/reintroduction actions[16].

i. Development of an M&E program for LCR chum salmon populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/reintroduction programs and habitat restoration actions.

ii. Development of associated budget.

Seven specific objectives are identified within the project components listed above:

Objective 1: Habitat restoration and chum channel site assessment;

Objective 2: Lower Columbia River chum salmon stock status review;

Objective 3: Develop an integrated supplementation/ reintroduction strategy for Lower Columbia River chum salmon;

Objective 4: Monitoring and evaluation program development within the context of an Adaptive Management Framework;

Objective 5: Grays River chum salmon supplementation;

Objective 6: Removal of invasive vegetation in Hamilton Spring channel; and

Objective 7: Initiate Three Step Review for a least one top ranked project identified by the habitat restoration and chum channel site assessment.

[16] An initial M&E Plan for the Duncan Creek Chum Project was developed by Schroder (2000); that document will be a starting point – in conjunction with our conceptual Adaptive Management Plan – for a comprehensive M&E Plan for Project 2008-710-00.

The detailed description of the WDFW Integrated Strategy for LCR chum salmon enhancement is presented in the following Section (below). The integration of the major components and deliverables outlined above is illustrated in Figure 5 of the following section.

Description of the WDFW Integrated Strategy for LCR Chum Salmon Enhancement

The WDFW Integrated Strategy for Project 2008-710-00 addresses the implementation phase of chum salmon recovery work as envisioned by the LCFRB (2004) Salmon Recovery Plan. The authors of the LCFRB (2004) Salmon Recovery Plan acknowledge that it is a conceptual framework to provide a systematic regional approach, but additional study designs, and statistical methodology will be detailed in project work plans that will be developed as implementation planning proceeds:

> *"This plan provides the framework for a systematic regional approach. It generally identifies what needs to be done and how to do it. It does not drill down into specific implementation details such as desired confidence levels, statistical power, data collection protocols, sample sizes, etc.* ***These details will depend on additional refinements to the monitoring, research, and evaluation elements of this plan that will be developed as implementation planning proceeds.*** *Refinements will be predicated on the availability of resources for conducting an integrated monitoring, research, and evaluation program."*

WDFW believes that a full review and subsequent revision of documentation that guides lower Columbia River chum salmon recovery (state/federal stock status reviews and recovery plans, risk assessments, etc.) needs to be conducted. An integrated plan for chum salmon management and restoration needs to be updated to reflect the latest data on chum salmon stocks in this ESU.

Significant new information has been collected regarding chum salmon population trends and genetic relationship structures since the initial NMFS LCR chum status Review (Johnson et al. 1997) and the LCFRB Recovery Plan was written in 2004. WDFW has done population assessments and concurrently collected chum salmon DNA samples from many locations in the LCR, and we plan on analyzing these samples immediately upon contract approval[17]. We will use this information to update chum salmon stock structure and genetic inter-relationships throughout the ESU – and this information is relevant to decisions on appropriate donor stocks for reintroduction into specific habitats. This new stock information will also be incorporated in Project 2008-710-00 Integrated Strategy and Adaptive Management –M&E Plan (Figure 1).

Another major change that has occurred since the LCFRB (2004) Plan was written is the decline of stronghold stocks. Populations that were generally increasing prior to 2003 – e.g., Grays,

[17] The existing genetic samples will be analyzed by the Science Division staff at the WDFW Molecular Genetics Lab; Dr. M. Small will be the principal investigator on the chum salmon population genetics analyses and subsequent update of previous publications.

Ives, I-205 – have shown a declining trend in recent years. Refer to the Population Status review in the Background section (above).

During the development of the integrated project strategy in year 1, we will concurrently be identifying and assessing potential reintroduction locations. This is an important initial step in recovering chum salmon below Bonneville Dam. There are already several locations in Washington tributaries that have been identified by WDFW as being very good candidates for habitat improvements and/or chum salmon reintroduction. The process of planning reintroduction implementation can and should occur concurrently with habitat assessments during the first year of the project. In addition, there are programs/actions that are already in earlier planning documents that will not happen in FFY09 without the funding that will be provided through Project 2008-710-00.

The sequencing of tasks in the development of WDFW's integrated strategy – during the first year of the project – to implement habitat restoration and chum reintroduction in the tributaries below Bonneville Dam is illustrated in Figure 5.

Schedule of Activities -- Timelines

Tracy Hauser, BPA COTR, has identified a pre-project start date for initial activites (July 1st) and a target contract start date of August 1, 2009. Project activities for months 1-12 of Performance Year 1 and 2 are described in Figures 6 and 7, respectively. Figure 5 (previous section) provides a schematic description of the sequencing of Year 1 activities that lead to the development of an Integrated Strategy for Chum enhancement in the lower Columbia River..

Project Performance Year 1

In the first year of the project, proposed activities fall within four main categories: Habitat restoration, Stock Status Assessment, Supplementation, and Population Monitoring & Evaluation (Figure 6).

Habitat Restoration

Primary activities and deliverables proposed for this category are:

1) Prioritized list of potential habitat restoration projects and chum spawning channel sites in Washington LCR tributaries describing the benefits of each.
2) Non-native vegetation (reed canary grass and Himalayan blackberry) removal from Hamilton Spring Channel.

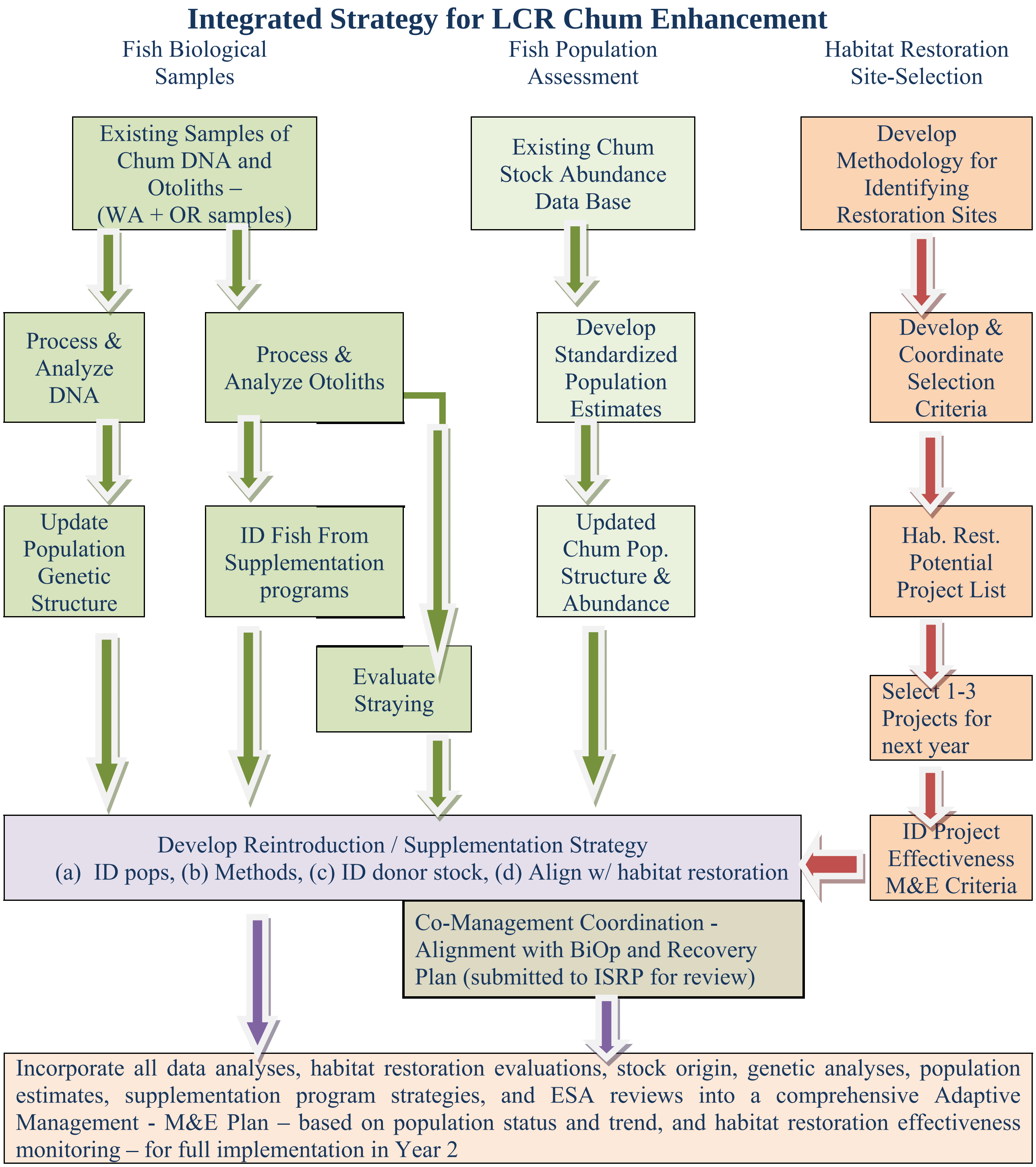


Figure 5. Flow chart of Project 2008-710-00 activities supporting the development of an Integrated Strategy for LCR Chum Enhancement.

The following section on timelines will provide additional details and descriptions regarding the schedule of activities and tasks presented in Figure 5 (above).

Chum Project Activities Timeline – Project Performance Year 1

Month Number of Contract Period – with Contract Start Date at Month-0

Contract Start=0	1	2	3	4	5	6	7	8	9	10	11	12
TASKS:	Habitat Restoration											
Chum Habitat Projects	Develop Criteria		List of Potential Projects		Rank Projects		Select 1-3 Projects	Develop Adaptive Mgt Hypotheses				
Hamilton Spgs. Veg. Removal	Obtain permit map existing veg / remove											
	Stock Status Assessment											
DNA – Otolith Analyses	Processing (WDFW Lab)		Analysis (Dr. Small)		Report & Technology Transfer							
Stock Status Review						Population Abundance Estimates + Stock Status Updates (Rawding / Ryding)				SaSI Update		
Review Existing Supplementation Projects			Compile & Review Grays River and Duncan Creek Supplementation Data – Adult Returns vs. Previous Releases				Develop Adaptive Mgt Hypotheses					
	Supplementation Strategy											
Grays River Supplementation	Complete Council's (combined) Three-Step Review for Gray's River – Continue in Fall 2009			Collect Adult Broodstock		Juvenile Rearing and Release						
Future Supplementation Strategy						Develop an Integrated Supplementation/Reintroduction Strategy for New and Ongoing Habitat Restoration and Chum Enhancement Projects (will be submitted to ISRP for review upon completion)						
	Co-Management Coordination and Alignment with BiOp and Recovery Plans											
Recovery Strategies - Integration	LCR Chum ESA Recovery Plan & FCRPS BiOp RPA Review											
	Population Monitoring & Evaluation											
Population Status RM&E						Develop or Revise Study Design and Statistical methodology for Population Status and Habitat Effectiveness Monitoring						
Overall RM&E Plan	Incorporate all data analyses, habitat restoration evaluations, stock origin, genetic analyses, population estimates, supplementation program strategies, and ESA reviews into a comprehensive RM&E Plan – based on population status and trend, and habitat restoration effectiveness monitoring – for full implementation in Year 2 (ISRP review)											
Assume Start 8-1-09	Aug 2009	Sep	Oct	Nov	Dec	Jan 2010	Feb	Mar	Apr	May	Jun	Jul

Figure 6. Linkage chart of stock assessment and habitat restoration tasks flowing into a comprehensive Supplementation Strategy and RM&E Plan for chum salmon restoration.

To develop a prioritized list of potential habitat restoration projects and chum salmon spawning channel sites, we propose to, first, finalize the criteria and process that will be used to evaluate projects. Our model for criteria development and project ranking is described in Appendix 7. Secondly, we propose to compile a comprehensive list of potential projects with direct benefit to chum salmon through a thorough review of existing habitat assessments, restoration project lists and newly proposed projects from 1) LCFRB (e.g. subbasin workgroups, watershed assessments, SRFB proposal process), 2) LCREP, 3) the BPA Estuary MOA, 4) WDFW, and 5) other salmon and habitat enhancement groups. The LCFRB (2009) project application and ranking criteria are presented in Appendix 8.

As stated in our initial proposal our intent "is not to conduct or re-evaluate habitat assessments already completed or compiled through the LCFRB or other processes, but instead to utilize the LCFRB Recovery Plan, existing stream habitat assessments and restoration project lists to develop a prioritized list of habitat restoration projects and/or locations within the LCR that would be the most beneficial to chum salmon." By month 5 of the project, we propose to begin evaluation and prioritization of the project list describing the potential benefits of each, so by month 7 we can select the 1-3 highest priority projects for initial scoping, preliminary budget development and integration into our reintroduction/supplementation strategy.

Removal of non-native vegetation from wetted areas of Hamilton Spring Channel would need to occur within the established in-water work window for this area of August 1st-31st. Work outside wetted areas of the channel (in some years the channel is completely dry) can likely be permitted outside of this work window. Assuming the timeline presented in Figure 7 begins August 1, 2009 this task would need to begin immediately if work is to be completed in 2009. A discussion of the merits of this proposed activity can be found in our response to ISRP Specific Comment #19 on page 96 of this document. In preparation for the potential completion of this task in August and September 2009, we have initiated the permitting process with WDFW's Habitat Division to ensure a Hydraulic Permit Application (HPA) and associated state and county permits can be secured in time. If this task is deferred or eliminated, the permit application(s) can be withdrawn.

Stock Status Assessment

Primary activities and deliverables proposed for this category are:

1. Processing and analysis of DNA and otolith samples.
2. Updated genetic analysis of LCR chum salmon population structure.
3. Update of WDFW's Salmonid Stock Inventory database (SaSI) with current population structure and updated abundance data.
4. Review of existing supplementation projects.

The DNA and otolith samples listed in Table 15 of this document have been collected and are currently archived. Processing of these samples would begin immediately upon project implementation with completion within the first three months of the project. Analysis of genetic samples and an initial summary report are proposed for completion by Dr. Maureen Small of the WDFW Molecular Genetics Laboratory by month 7 of the project. This analysis will update previous work on LCR chum salmon population structure (Small et al. 2004 and 2006) and results will be integrated into the development of our reintroduction/supplementation strategy.

A review of historical chum stream survey data, and development of standardized population abundance estimates are proposed for months 6-10 of the project. Combined with updated population structure information from the genetic analysis, this information will be used to update WDFW's Salmonid Stock Inventory (SaSI) database. A review of current supplementation programs on the Grays River and Duncan Creek, incorporating complete decoded otolith data, is proposed for months 2- 7 of the project, and will help direct adaptive management of these projects. Results of these reviews will be key elements in directing our reintroduction/supplementation strategy and in finalizing an RM &E plan.

Supplementation

Primary activities and deliverables proposed for this category are:

1) An NPCC Three-Step review for the Grays River Supplementation Program.
2) Up to 200,000 chum fry released from the Grays River Hatchery, thermally marked for identification upon recovery via otoliths from adult carcasses.
3) Development of a reintroduction/supplementation strategy for LCR chum salmon to link with habitat restoration and chum channel project implementation, including:
    a. Identification of priority populations for reintroduction/supplementation.
    b. Identification of reintroduction/supplementation method(s) suitable for priority populations.
    c. Identification of genetic stock source for reintroduction/supplementation of priority populations.

We propose to continue the Grays River chum supplementation program (currently unfunded) in 2009/10 by, first, conducting an NPCC Three-step Review for the program. For brand new hatchery programs or hatchery facilities, this process can be quite lengthy; however, for existing programs and facilities it is possible to conduct a "combined" Three-step review. Authors of this proposal successfully completed a combined Three-step review for the Duncan Creek chum supplementation program (Washougal Hatchery) in 2003. We propose to follow a similar format to the Duncan Creek review for the existing Grays River program, and have initiated discussions with Mark Fritch (NPCC F&W Program Implementation Coordinator) to begin the combined Three-step process. Completion of this review is proposed to occur within the first three months of the project, to allow broodstock collection in November 2009. Current program size is targeted at up to a 200,000 fed-fry release in the spring of 2010; however a review of the existing program and the Three-step review process will be used to develop adaptive management strategies for the program.

In month 6 of the project, after completion of the genetic analysis to update population structure and identify potential donor stocks, we propose to begin finalizing a reintroduction/supplementation strategy for LCR chum. As population abundance data updates, existing supplementation program review, and habitat project list development and selection are completed, these elements will be integrated into the strategy. A final strategy is proposed for completion at the end of performance year 1, and will be made available to BPA and the ISRP for review before implementation in performance year 2.

Population Monitoring and Evaluation

Primary activities and deliverables proposed for this category are:

1) Development of an M&E program for LCR chum populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/reintroduction programs and habitat restoration actions.
2) Development of associated budget.

Development of a comprehensive Adaptive Management-M&E plan integrating the LCFRB (2004) and NOAA Fisheries Service (2007, 2009) monitoring frameworks and priorities identified in the FCRPS BiOp will occur throughout performance year 1 (see Appendix 5 and 6). After month 7 of the project, results from habitat restoration, stock status assessment, and supplementation strategy development (described above) will be integrated into the final M&E plan. Appendices 5 and 6 elaborate on the conceptual design of the M&E plan proposed for completion at the end of performance year 1, which will be made available to BPA and the ISRP for review before implementation in performance year 2.

Project Performance Year 2:

For Year 2 of the project, proposed activities continue work within three categories: Habitat restoration, Supplementation, and Population Monitoring & Evaluation (Figure 7).

Habitat Restoration

Primary activity proposed for this category:

1) Initiate design, permitting, and/or construction of the 1-3 priority habitat restoration/chum channel projects identified in Year 1.

Depending on the scope, and projected cost of priority habitat projects identified in Year 1, one to three projects will be selected for implementation in Year 2. Work in Year 2 will consist of, design and engineering, final cost projections, permitting, and possibly construction.

Construction in Year 2 will depend on the scope and size of the project, permitting, and alignment with in-water work windows.

Supplementation

Primary activities proposed for this category are:

1) Continuation of Grays River supplementation program.
2) Restore the Duncan Creek supplementation program.
3) An NPCC Three-Step review for the newly identified supplementation program(s).

In Year 2, the Grays River supplementation program is proposed to continue with broodstock collection in November-December 2010, and juvenile releases in spring of 2011. Program size, and rearing strategies will be dependent on the Year 1 review of the existing program and the NPCC Three-Step review process.

We also propose to restore the supplementation program for Duncan Creek, which was originally a component of the BPA funded (and ISRP reviewed) project - Reintroduction of Chum Salmon into Duncan Creek (#200105300). Broodstock collection for this program is proposed from November – December 2010. Egg incubation and initial rearing, and marking occurs at the Washougal Hatchery and fish will be released in April/May 2011.

Reintroduction and/or supplementation programs identified in Year 1 strategy development, corresponding to priority habitat projects, are proposed for implementation beginning in Year 2. The first step of implementation will be completion of a NPCC Three-Step review of these projects.

	Month Number of Contract Period – with Contract Start Date at Month-0											
Contract Start=0	1	2	3	4	5	6	7	8	9	10	11	12
TASKS:	Habitat Restoration											
Chum Habitat Projects	Initiate design, permitting, and/or construction of the 1-3 priority habitat restoration/chum channel projects identified in Year 1.											
	Supplementation Strategy											
Grays River Supplementation				Collect Adult Broodstock		Juvenile Rearing and Release						
Duncan Creek Supplementation*				Collect Adult Broodstock		Juvenile Rearing (Washougal Hatch.) and Release (Duncan Ck.)						
New Supplementation Program(s)	Conduct Council's Three-Step review, develop HGMP (if artificial production is to be utilized), and begin planning for new supplementation/reintroduction program (s) identified in Year 1 (Supplementation Strategy) – in alignment with habitat restoration/chum channel projects.											
	Implementation of Population Monitoring & Evaluation Plan											
Adult Chum M&E – Incorporate and align existing BPA projects.			BPA projects – "Below the Dams" (#199900301) and Reintro. of chum in Duncan Ck. (#200105300)									
-Implement other status and trend & effectiveness monitoring.			Implement in Grays River and other areas as outlined in M&E plan (Year 1).									
Juvenile Chum M&E – Incorporate and align existing projects.							**BPA project:** Reintro. of chum in Duncan Ck. (#200105300). **NOAA BiOp funding:** Grays River juvenile trap					
Implement other status and trend & effectiveness monitoring.							Implement in Hardy & Hamilton Creeks and other areas as outlined in M&E plan (Year 1).					
Assume Start 8-1-10	Aug 2010	Sep	Oct	Nov	Dec	Jan 2011	Feb	Mar	Apr	May	Jun	Jul

Figure 7. Chum salmon enhancement project activities timeline – Project Performance Year 2.

Population Monitoring and Evaluation

Primary activity proposed for this category:

1) Implementation of Population Monitoring and Evaluation Program developed in Year 1.

Two BPA funded (and ISRP reviewed) projects currently conduct adult and juvenile chum monitoring – Evaluate Spawning of Fall Chinook and Chum Salmon Just Below the Four Lowermost Mainstem Dams ("Below the Dams) (#199900301) and Reintroduction of Lower Columbia River Chum Salmon into Duncan Creek (#200105300). Additionally, a project on the Grays River (funded through 2009, primarily via NOAA BiOp funds) conducts juvenile monitoring for chum salmon. In Performance Year 2, proposed implementation of the Adaptive Management-M&E plan (see Appendix 6) developed and reviewed in Year 1 will consist of integrating these existing adult and juvenile monitoring projects with newly developed monitoring activities. Monitoring of adult spawner abundance will occur in the fall of 2010, with subsequent juvenile monitoring in spring 2011.

BUDGET PROPOSAL – With Supporting Narrative

Habitat Restoration

Phase 1 (FFY 2009) Habitat Restoration and Chum Channel Site Assessment

The LCFRB Salmon Recovery Plan (2004) is a comprehensive document that outlines an integrated approach for recovery of LCR salmonid populations. For LCR tributaries in Washington State, limiting factors affecting salmonid populations are identified, habitat quantity and quality is assessed at the stream-reach level, and stream reaches are prioritized for preservation and restoration. The LCFRB has identified a 6-year habitat work schedule (http://www.lcfrb.gen.wa.us/2008%20HWS.htm) for implementation of it's habitat restoration strategy and sponsors community-based work groups to develop and implement watershed specific habitat restoration plans. For Oregon LCR salmonid populations, a similar recovery planning process is underway.

The intent of this proposal is not to conduct or re-evaluate habitat assessments already completed or compiled through the LCFRB or other processes, but instead to utilize the LCFRB Recovery Plan, existing stream habitat assessments and restoration project lists to develop a prioritized list of habitat restoration projects and/or locations within the LCR that would be the most beneficial to chum salmon.

The construction of artificial, or restoration of historic chum spawning channels has been used as tool in supplementing natural spawning chum salmon populations, by mitigating for lost habitat. In British Columbia, Canada, large scale artificial chum channels are utilized to support production level chum salmon programs. Some channels are associated with a hatchery, others are independent, for example:

- Big Qualicum Hatchery – artificial channel - 300,000 chum
- Big Qualicum – spawning channel – 20,000 chum – 20 million fry
- Little Qualicum – artificial channel - 50,000 chum – 59 million fry
- Stave River – off-channel enhanced spawning area

In the LCR examples of constructed/restored chum spawning channel locations include:

1) Gorley Springs channel, which operated on the Grays River from mid 1980s until a major river avulsion overtook the area in 1998,
2) Hamilton Creek Spring Channel restored in the mid-1990s, and
3) Duncan Creek spawning channels restored in 2001.

Stream surveys conducted on WA state tributaries of the lower Columbia River from 1998-2000 identified spring-fed sites where chum salmon were observed spawning. A review of these locations for potential habitat improvements and/or a chum spawning channel will be included in this assessment.

The criteria/metrics that will be used for ranking habitat restoration and chum channel locations will be finalized prior to assessment, but should consider the following:

- Population recovery designation for affected chum salmon population - “primary” or “core” designations (LCFRB and Lower Columbia/Willamette TRT, respectively; (Table 2) should be given priority.
- Quantity/quality of restored habitat provided.
- Life history stage(s) benefitted.
  - Is creation of spawning habitat part of the project?
  - What level of spawner abundance will be supported?
- Documentation of current or historic spawning in the location.
  - Is or was the location used by chum salmon?
- Feasibility/Risk Assessment.
  - How likely is it that the project will be successful?
  - How stable is the location?
  - Build on LCFRB work group and other assessments where available.
- Cost – if estimates are available.
  - Utilize LCFRB and other project lists where available.

Habitat Project Assessment Deliverables

1. Prioritized list of potential habitat restoration projects and chum spawning channel sites in Washington LCR tributaries describing the benefits of each.

FFY 09 Habitat work

Hamilton Spring channel is one of only two (Duncan Creek spawning channels being the other) protected off-channel chum salmon spawning areas in the Bonneville area. Non-native vegetation (reed canary grass and Himalayan blackberry) has encroached into the spawning channel to the extent that it is reducing the amount of available spawning area. In addition, the canary reed grass captures fine sediments instead of letting them flush from the area thus reducing the quality of the spawning gravel.

To remedy this, we propose to remove the canary reed grass from the spawning channel graveled/watered areas. Removal will be done by hand using hand tools only.

Phase 2 (FFY 2010) Habitat Restoration, Chum Channel Design and Implementation

Based on the FFY 2009 assessment, high priority habitat restoration and chum spawning channel projects will be submitted for design and implementation in FFY 2010. The number of projects moved forward in a single year will be dependent upon project scope, complexity, and ultimately project cost. The timeline for project completion is also driven by these factors; smaller scale, less complex projects are more easily designed, permitted and constructed than large, complex projects. We expect that between 1 and 3 projects would be initiated in FY 2010 (Table 17).

Budgeting for projects in FFY 2010 will be difficult until specific projects are identified. As an example of a fairly large-scale project, the budget for a project that modifies the return water from the WDFW Beaver Creek Hatchery facility on the Elochoman River into a chum salmon spawning channel has been included (an innovative proposal submitted to BPA in 2008). This project proposed creating spawning habitat for 200 or more adult chum.

Table 17. FFY 2009 proposed budget and estimate of FFY 2010 budget[18] for Habitat Restoration/ Chum Channel Design and Implementation.

	FFY 09		FFY 10	
Element/Action	WDFW funding	BPA Funding	WDFW funding	BPA Funding
Habitat Restoration and Chum Channel Site Assessment				
WDFW Staff		$20,000		
HAMILTON SPRING CHANNEL VEGETATION REMOVAL				
		$8,000		
Habitat Restoration/Channel Design and Implementation				
Initiate 1 to 3 Project(s) for Design and Construction (*e.g.* Beaver Creek Chum Channel)				$375,000
BPA Budget Request Subtotal	$0	$28,000	$0	$375,000

Stock Status Review

FFY 2009 – Sample Analysis and Stock Status Review

The genetic analysis completed by Small et al. (2006) utilized samples collected through 2002. Since then, additional monitoring and sample collection (genetic tissue samples and otoliths) has been completed. An updated stock status review of LCR chum salmon, population (genetic) structure and abundance is critical to identifying and prioritizing where restoration actions will be most beneficial, what type of supplementation or reintroduction strategy is appropriate, and identifying potential donor stocks for these programs. This update/review will include:

- Analysis of genetic tissue and otolith samples collected in 2003-08 (Table 18).
- An updated analysis of LCR chum salmon population (genetic) structure.
- Review and update of historic and recent chum salmon abundance data.
- Review of existing supplementation programs (i.e. Grays River and Duncan Creek) – determine the contribution of supplementation programs to the natural spawning population.

[18] Note: all FFY2010 budgets in this proposal are preliminary estimates that will be developed in more detail after completion of FFY 2009 work.

- Review of recovery strategies outlined in the LCFRB's Recovery Plan (2004), the FCRPS Biological Opinion and coordination with other relevant management entities.

Table 18. Number of LCR chum salmon otolith and DNA samples proposed to be analyzed for stock status review.

Location/Area	Otolith Samples	DNA samples
Coast Stratum		
Grays and Chinook Rivers	200	150
Elochoman and Skamokawa Rivers	271	231
Big Creek Hatchery (OR)	0	50
Germany, Abernathy and Mill Creeks	15	11
Cascade Stratum		
Germany, Abernathy and Mill Creeks	15	11
Cowlitz and Coweemen Rivers	0	49
Lewis and NF Lewis Rivers	96	37
Kalama River	1	0
Gorge Stratum		
Mainstem spawners		
I-205 (Washougal Population)	0	150
St Cloud/Multnomah line to Bonneville	0	150
Tributary spawners		
Misc. Tributaries	46	43
Hamilton and Hardy Creeks	0	100
Above Bonneville Dam		
All populations	5	27
All locations in 2008 (estimated)		
	100	100
TOTAL	734	1,098

Stock Status Review Deliverables:

1. Processing and analysis of samples identified in Table 18.
2. Updated genetic analysis of LCR chum salmon population structure.
3. Update of WDFW's Salmonid Stock Inventory database (SaSI) with current population structure and updated abundance data.

The estimated budget is presented in Table 19.

Table 19. FFY 2009 proposed budget and estimate of FFY 2010 budget for Stock Status Review

	FFY 09		FFY 10	
Element/Action	WDFW funding	BPA Funding	WDFW funding	BPA Funding
Chum Stock Status Review				
Update DNA analysis and complete Otolith analysis from all basins		$85,000		
Update SaSI Abundance Data		$30,000		
BPA Budget Request Subtotal	$0	$115,000	$0	$0

Supplementation

FFY 2009 - Maintain Grays River Supplementation Program / Develop Strategy for Future Supplementation/Reintroduction Programs.

Grays River Supplementation

Chum salmon in the Grays River have been identified as a primary population targeted to improve to a level that contributes to recovery of the species (LCFRB 2004). The Grays River population is one of only two remaining substantial populations (recent natural origin returns greater than 1,000 adults) utilizing the LCR and its tributaries. An artificial, spring-fed spawning channel was constructed in 1985 off of Gorley Creek to provide protected off-main-channel spawning. In 1998, WDFW initiated a chum salmon supplementation program using native stock on the Grays River. This program has continued through 2007, but is currently unfunded. This supplementation effort was initiated because it was believed that most successful natural spawning was limited to spring-fed areas in Gorley and Crazy Johnson creeks. The creeks were believed to have a high risk of failure due to flooding and potential re-alignment of the mainstem Grays River. In December of 1998, a freshet caused a major avulsion through a man-made dike that had protected Gorley Creek and the artificial spawning channel; the mainstem Grays River now runs through the Gorley Creek streambed. The loss of the Gorley Creek off-channel spawning area increased extinction risk by limiting the most successful spawning to approximately half of Crazy Johnson Creek. The WDFW believes that supplementation should continue until other spawning sites outside Crazy Johnson Creek are restored and proven to be successful.

A geomorphological and hydrological assessment of the Grays River and its tributaries from RM 11 to the headwaters was implemented in 2003 (BPA Project # 200301300), in order to gain a better understanding of the location, distribution, characteristics and stability of salmonid spawning habitat within the basin, with emphasis on chum salmon. The focus of this project has switched to implementation of habitat restoration projects identified through the assessment and BPA is currently funding a large-scale habitat restoration project in the Gorley Reach to be completed in summer 2009. A goal of this project is to stabilize and reconnect Gorley Springs to the mainstem Grays River.

Infrastructure, staffing, and permitting are in place to continue this supplementation project without interruption—with broodstock collection in November & December of 2008. This program buffers catastrophic risk to the Grays River chum population and will become more important if Grays River chum are used as the donor stock for other LCR supplementation/reintroduction programs in the future.

The Grays River program was modeled on, and developed under, the guiding standards of successful chum salmon supplementation programs implemented in the Puget Sound and Hood Cannel (WDFW and PNPTT 2000, Ames and Adicks 2003, Johnson et al. 2003). Broodstock from returning chum salmon are collected in the fall from the mainstem and West Fork (WG) Grays River and Crazy Johnson Creek. Spawning is conducted at WDFW's Grays River Hatchery (located on the WF Grays River), where eggs are incubated and hatched. Fry are thermally marked (detectable on the otolith) and are released in the spring of the following year. Specific details of the program are described in the Draft Grays River Chum Salmon Hatchery & Genetic Management Plan (HGMP) submitted to NMFS (WDFW 2004a). This supplementation program is very similar to the program implemented under BPA project # 200105300 Reintroduction of Chum salmon into Duncan Creek, which has been approved through the Northwest Power and Conservation Council's (NPCC) Three-step Review process (letter dated March 16, 2005, from Doug Marker to William Maslen, Manager Fish and Wildlife Division, BPA).

In FFY 2009, we propose to avoid interruption of the on-going Grays River chum salmon supplementation program by capturing broodstock in November and December of 2008, with the goal of collecting 100,000 to 200,000 eggs. As part of the aforementioned stock status review, contribution of supplementation program releases to the natural spawning population will be assessed through analysis of otolith and DNA samples. In addition, a Three-step review for the program will be initiated through the NPCC process for completion by the beginning of FFY 2010.

Future Supplementation/Reintroduction Strategy Development

To date, WDFW's restoration approach for chum salmon has been as follows:

Step 1. Determine if remnant populations of chum salmon exist in the system.

Step 2. If such populations exist, develop stock-specific recovery plans involving habitat restoration that include the creation of spawning refugias, supplementation where necessary, and a habitat and fish monitoring and evaluation plan.

Step 3. If chum salmon have been extirpated from previously utilized streams, develop reintroduction plans that utilize appropriate genetic donor stock(s), and integrate habitat improvement and fry-to-adult survival evaluations.

As exemplified by the Grays River hatchery program described above, conservation level hatchery supplementation programs can be utilized to buffer populations against catastrophic risk. As habitat restoration and other recovery efforts for depressed LCR chum populations move forward, supplementation of remnant populations or reintroduction of extant populations can also be an effective tool in jump-starting recovery and utilization of newly restored/created habitat. The BPA funded Duncan Creek reintroduction project (#2001-053-00) is an example of the latter. Results from this on-going project will help to direct future supplementation strategy development. A detailed monitoring and evaluation (M&E) plan for Duncan Creek reintroduction strategies has been developed (Schroder 2000) and will provide a useful template for future programs.

Stream surveys conducted by WDFW and PSMFC staff in recent years have documented low-level chum spawning activity in many of Washington States' LCR tributaries. Spring-fed seeps and upwelling areas were identified during these surveys; genetic tissue and otolith samples were collected from chum salmon carcasses in these locations (Table 5). The proposed stock status review, to be completed as part of this project, is intended to provide updated information on genetic structure useful in further determining if chum spawning in these areas are genetically distinct remnant populations or extensions of larger neighboring populations. Otolith analysis will be used to detect straying from the Grays River or Duncan Creek supplementation programs.

In FFY 2009, we propose to develop a strategy that incorporates population recovery designations (Table 5), updated genetic and abundance information and potential habitat restoration/chum channel projects in identifying 1) priority populations for supplementation/reintroduction, 2) preferred methods of supplementation/reintroduction for these populations, and 3) the genetic stock source (donor stock) for each.

Supplementation Deliverables

1) Up to 200,000 chum fry released from the Grays River Hatchery in spring 2009, thermally marked for identification upon recovery of otoliths from adult carcasses.
2) An NPCC Three-step review for the Grays River Supplementation Program.
3) Development of a supplementation/reintroduction strategy for LCR chum salmon to link with habitat restoration and chum channel project implementation. Including:
    a. Identification of priority populations for supplementation/reintroduction.
    b. Identification of supplementation/reintroduction method(s) suitable for priority populations.
    c. Identification of genetic stock source for supplementation/reintroduction of priority populations.

FFY 2010 – Supplementation Program Development and Implementation[19]

The estimated supplementation program budget is presented in Table 20.

Grays River

Continue the Grays River chum salmon hatchery supplementation program. Collect sufficient adults to produce approximately 200,000 otolith marked fed-fry for release into the Grays River system.

Duncan Creek

Reinitiate the Duncan Creek hatchery supplementation program (funding reductions in FFY08 eliminated this program). Hatchery infrastructure (Washougal), an HGMP, and an approved Three-step review are currently in place. The program will produce otolith marked fed-fry for direct release at Duncan Creek.

New Programs

As other priority habitat restoration and chum channel projects are designed and implemented, corresponding supplementation/reintroduction programs will be developed. New programs will need to be approved through NPCC Three-step review process, which includes development of an HGMP incorporating an analysis of risks (partial/total hatchery loss, predation, competition, disease, loss of genetic variability between or within populations) resulting from a hatchery supplementation program, determining allowable fish release levels, disposition of excess individuals, and maintenance of ecological and genetic characteristics of the natural population (brood stock collection, spawning, incubation, juvenile rearing and smolt release procedures).

Monitoring and evaluation standards will be developed to collect data needed to evaluate performance measures, identify adaptive management actions that can be taken if the program is not meeting goals, and to determine when to stop the program. Monitoring and evaluation plans will be modeled on the existing M&E plan for Duncan Creek (Schroder 2000) and existing Grays River chum and Washougal Hatchery HGMPs (WDFW 2004a, 2004b).

[19] Note: all FFY2010 work elements and budgets in this proposal are provisional, and will be developed in more detail during implementation of FFY 2009 work.

Table 20. FFY 2009 proposed budget and estimate of FFY 2010 budget for Chum Salmon Supplementation/Reintroduction.

	FFY 09		FFY 10[20]	
Element/Action	WDFW funding	BPA Funding	WDFW funding	BPA Funding
Chum Salmon Supplementation				
Grays River				
WDFW Staff		$35,000		37,000
Complete Three-step Review		$10,000		
LCR Tributary Supplementation Strategy Development				
Strategy Development		$35,000		
Duncan Creek				
Reinstate supplementation program WDFW Staff				94,000
New Programs				
Implementation of new supplementation / reintroduction program – includes one time cost (75K) of purchasing chillers for thermal marking				$130,000
Initiate HGMP and Three-step review(s) for newly identified program(s).		$5,000		
Complete HGMP and Three-step review(s)				$15,000
BPA Budget Request Subtotal		$85,000		$276,000

Population Monitoring and Evaluation

The general approach and conceptual framework to develop the experimental design for Objective 2 (stock status review) and Objective 4, (population monitoring and evaluation) is presented in Appendix 5.

[20] Note: all FFY2010 budgets in this proposal are preliminary estimates that will be developed in more detail after completion of FFY 2009 work.

FFY 2009 Ongoing Monitoring

Adult Chum Salmon Abundance Monitoring

In FFY09, adult chum salmon abundance monitoring via stream surveying is occurring in the Grays and Cowlitz Rivers, Mill, Abernathy, and Germany (MAG) creeks, and for the Lower Gorge population(s) (Washington tributaries and mainstem Columbia River spawning areas between the I-205 Bridge and Bonneville Dam) (Table 21). Monitoring for Upper Gorge populations occurs via counts made at Bonneville Dam fish counting stations. No additional funding for on-the-ground monitoring is being requested for FFY09.

Monitoring for the Grays River, MAG creeks, and Lower Gorge population utilizes a combination of Area-Under-the-Curve (AUC) (English et al. 1992), and Jolly-Seber (JS) mark-recapture (Jolly 1965 and Seber 1965) methodologies to develop accurate and precise estimates of total abundance. A detailed description of methodologies can be found in Rawding and Hillson (2003) and Rawding et al. (2006).

Table 21. Current and proposed adult chum salmon abundance monitoring locations, methods and funding source.

		FFY 2009		FFY 2010	
Washington Populations	**LCFRB Recovery Designation**	**Current Method(s)**	**Current Funding**	**Proposed Method(s)**	**Proposed Funding**
Coast Stratum					
Grays (Grays/Chinook)	Primary	JS, AUC_C	SRFB	W, JS, AUC_C	SRFB
Chinook (Grays/Chinook)	X	NS		AUC_C	BPA
Elochoman (Eloch/Skam)	Primary	NS		JS, AUC_C	BPA
Skamokawa (Eloch/Skam)	Primary	NS		AUC_C	BPA
Mill/Abernathy/Germany	Primary	AUC-C	SRFB	AUC_C	SRFB/BPA
Cascade Stratum					
Cowlitz	Contributing	SP	WDFW	MP, AUC_I	BPA
Coweeman (Cowlitz Trib)	X	NS		MP, AUC_I	BPA
SF Toutle (Cowlitz Trib)	X	NS		MP, AUC_I	BPA
NF Toutle (Cowlitz Trib)	X	NS		MP, AUC_I	BPA
Green (Cowlitz Trib)	X	NS		MP, AUC_I	BPA
Kalama	Contributing	NS		MP, AUC_I	BPA
Lewis (EF and NF)	Primary	NS		AUC_C	BPA
Salmon	Stabilizing	NS		MP, R_PS	BPA
Washougal	Primary	NS		JS, AUC_C	BPA
Gorge Stratum					
Lower Gorge Tribs./mainstem Columbia	Primary	JS, AUC_C	BPA	JS, AUC_C	BPA
Upper Gorge Tribs.	Contributing	W	USACE	W	USACE

Abbreviation **Definition**

Abbreviation	**Definition**
W	Weir
JS	Jolly-Seber Mark-Recapture
AUC_C	Area-Under-the-Curve w/ census of spawning distribution
AUC_I	Area-Under-the-Curve w/ index sampling expanded for historical index use
SP	Single Pass count of redds, deads, lives
MP	Multiple Pass count of redds, deads, lives
R_PS	Redd Count w/ Probablilistic Sampling
X	Part of Larger Population
NS	No Surveys directed at chum monitoring
BPA	Bonneville Power Administration
SRFB	Salmon Recovery Funding Board (Washington State)
USACE	US Army Corp of Engineers - Bonneville Dam Counts

Juvenile outmigrant monitoring

Chum salmon juvenile outmigrant monitoring will be conducted using existing funding on the Grays River in the spring of 2009. A rotary screw trap will be operated from late January through July, 2009, following established protocols. Smolt yield will be estimated using trap efficiency methods (MacDonald and Smith 1980, Dempson and Stansbury 1991, Thedinga et al. 1994, Schwarz and Dempson 1994). Since trap efficiencies may change in relation to stream flow (Cheng and Gillinant 2004), a stratified experimental design is utilized where juveniles are batch marked with a unique mark for every week at each location. The population estimates obtained using this type of experimental design are often referred to as a stratified Petersen or Darroch estimate (Darroch 1961, Arnason et al. 1996, Bennahaka et al 1997, Plante et al. 1998). Rawding and Cochran (2005) and Sharpe and Glaser (2005) describe similar juvenile monitoring programs for the Wind and Coweeman Rivers, respectively.

As part of the Duncan Creek reintroduction project (BPA project #2001-053-00), trapping efforts each spring provide an annual estimate of juvenile chum outmigrating from the restored spawning channels. Fixed cross weirs provide anchor points for downstream migrant traps installed in the spring. Trap efficiency is normally 100%. A detailed M&E plan has been developed for the Duncan Creek reintroduction program (Schroder 2000) and Hillson (In prep.) describes recent program results.

FFY 2009 Population Monitoring and Evaluation Program Development

A well-developed population M&E program for LCR chum salmon should address three needs associated with recovery actions:

1) Biological monitoring necessary to assess stock status via VSP parameters associated with ESA listing and potential de-listing criteria.

2) Biological monitoring associated with supplementation/reintroduction programs to guide adaptive management.
3) Effectiveness monitoring associated with habitat restoration actions.

Currently, for most LCR salmon and steelhead populations, monitoring is directed at addressing stock status. For LCR chum salmon, the supplementation programs on the Grays River and reintroduction at Duncan Creek have prompted increased monitoring for these populations. As future habitat restoration projects and supplementation programs are implemented, the need for a coordinated M&E program will increase.

Since ESU status is a role up of individual population status, all adult chum salmon populations within the ESU must be monitored; however, the level of monitoring for each population is not likely to be equal. Populations designated as primary by the LCFRB or core by the Lower Columbia/Willamette TRT (Table 5) will need to be monitored more intensively than contributing or stabilizing populations. As supplementation/ reintroduction programs are implemented monitoring needs may change and adaptive management will be required.

For biological monitoring, there should be negligible bias in population estimates and the level of precision should be consistent with the management or recovery goal. Probably the most cited work for precision is over 40 years old. Robson and Reiger (1964) assumed a value of $\alpha = 0.05$ and recommend various levels of precision based on the purpose of data collection. They recommend 95% Confidence Intervals (CI) of less than + 10% for research into population dynamics, which may also be reasonable for some aspects of hatchery, habitat, harvest, and hydro effectiveness monitoring. For accurate management they advocated 95% CI that are less than ± 25%, which may correspond to the desired level for status and trends monitoring. For preliminary studies or for rough population estimates 95% CI intervals that are less than ± 50% were recommended. Cousens et al. (1982) defined monitoring programs with 95%CI less than +20% as good.

Depending on the desired precision goal, sample design development can utilize a variety of methodologies including census counts, mark-recapture via live fish or carcass tagging, Area-Under-the-Curve from live counts, peak count expansion, and redd counts. In general, sampling designs for higher levels of precision are more complex and costly. Figure 8 is a representation between cost of monitoring and accuracy of the monitoring.

In FFY09, we propose to develop a comprehensive Adaptive Management-M&E program for LCR chum populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/reintroduction programs and habitat restoration actions (Refer to Appendix 9 for the conceptual framework). It outlines a potential strategy for future adult abundance monitoring. Future juvenile monitoring is proposed for at least one primary population per stratum. Figure 8 shows how costs generally increase with increased complexity of monitoring study designs.

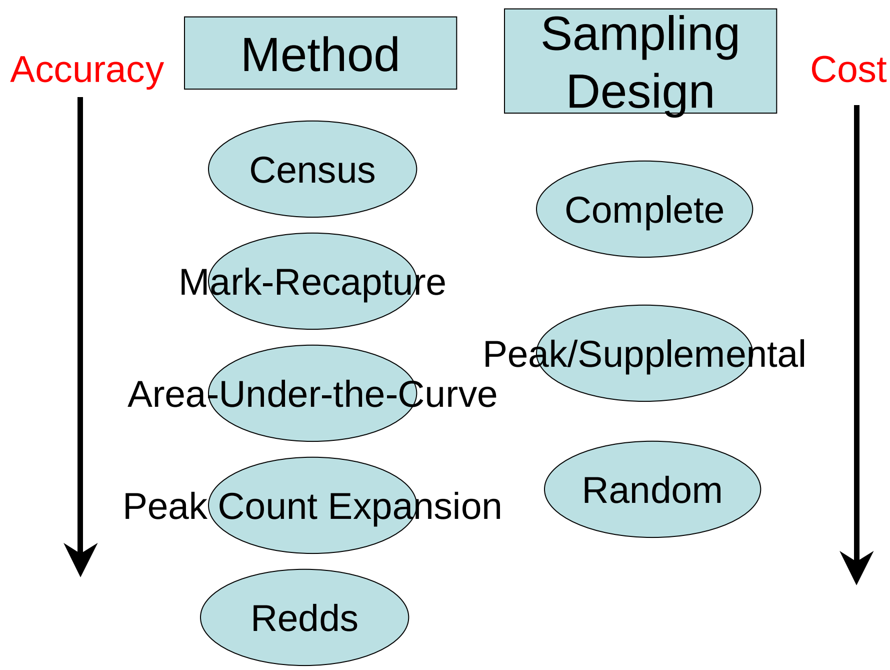


Figure 8. Generalization of trade offs between accuracy and cost of monitoring programs including the methods used to estimate abundance and the spatial sampling design. (Figure provided by Dan Rawding, WDFW).

Population M&E Deliverables:

1. Development of an M&E program for LCR chum populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/reintroduction programs and habitat restoration actions.
2. Development of associated budget.

FFY 2010 - Implementation of Population Monitoring and Evaluation Plan

The estimated population monitoring and evaluation budget is presented in Table 22. In FFY 2010, we propose to implement biological monitoring for LCR chum salmon in accordance with the plan developed. 1. WDFW will develop a subcontract with PSMFC to assist with adult population monitoring at selected sites beginning in FFY2010. WDFW and PSMFC staff have a long-term collaborative working relationship on chum monitoring projects at various lower Columbia River sites, and PSMFC staff have specific experience that will be valuable on this project.

Table 22. FFY 2009 proposed budget and estimate of FFY 2010 budget for Population M&E Program Implementation

	FFY 09		FFY 10[21]	
Element/Action	WDFW funding	BPA Funding	WDFW funding	BPA Funding
Population/Effectiveness Monitoring[1.]				
Grays River Population (adult))	$55,000		$55,000	
Grays River Population (juvenile)	$30,000	$55,000		$55,000
I-205 to Bonneville Dam Populations		$360,000		$360,000
Small populations between Grays River and I-205	$2,500			$70,000
M&E Program development		$35,000		$8,000
1. A PSMFC Subcontract will be developed to assist with adult population monitoring at selected sites beginning in FFY2010.				
BPA Budget Request Subtotal		$35,000		$493,000

Key:	Ongoing Project – Existing Budget	
	FFY 2009 Budget Request – This Proposal	
	FFY 2010 Projected/Estimated Cost	
	No Element/Action identified for completion.	

[21] Note: all FFY2010 budgets in this proposal are preliminary estimates that will be developed in more detail after completion of FFY 2009 work.

Overall FFY 2009 Budget Request and FFY2010 Estimate

The following budget Table 23 outlines costs associated with tasks and deliverables described in this proposal. Costs for FFY 2009 reflect first year funding requested for this proposal. FFY 2010 costs are preliminary coarse level estimates and will be further developed during work completed in FFY 2009.

Table 23. Overall Proposed Element/Action FFY 2009 and 2010 Budgets.

	FFY 09		FFY 10	
Element/Action	WDFW funding	BPA Funding	WDFW funding	BPA Funding
Habitat Restoration and Chum Channel Site Assessment				
WDFW Staff		$20,000		
HAMILTON SPRING CHANNEL VEGETATION REMOVAL				
		$8,000		
BPA Budget Request Subtotal	$0	$28,000	$0	$0
Habitat Restoration/Channel Design and Implementation				
Initiate 1 to 3 Project(s) for Design and Construction (*e.g.* Beaver Creek Chum Channel)				$375,000
BPA Budget Request Subtotal	$0	$0	$0	$375,000
Chum Stock Status Review				
Update DNA analysis and complete Otolith analysis from all basins		$85,000		
Update SaSI Abundance Data		$30,000		
BPA Budget Request Subtotal	$0	$115,000	$0	$0
Chum Salmon Supplementation				
Grays River				
WDFW Staff		$35,000		37,000
Complete Three-step Review		$10,000		
LCR Tributary Supplementation Strategy				

Element/Action	FFY 09 WDFW funding	FFY 09 BPA Funding	FFY 10 WDFW funding	FFY 10 BPA Funding
Development				
Strategy Development		$35,082		
Duncan Creek				
Reinstate supplementation program WDFW Staff				94,000

Table 10. Continued

Element/Action	FFY 09 WDFW funding	FFY 09 BPA Funding	FFY 10 WDFW funding	FFY 10 BPA Funding
New Programs				
Implementation of new supplementation / reintroduction program – includes one time cost (75K) of purchasing chillers for thermal marking				$130,000
Initiate HGMP and Three-step review(s) for newly identified program(s).		$5,000		
Complete HGMP and Three-step review(s)				$15,000
BPA Budget Request Subtotal		$85,082		$276,000
Population/Effectiveness Monitoring[1]				
Grays River Population (adult))	$55,000		$55,000	
Grays River Population (juvenile)	$30,000	$55,000		$55,000
I-205 to Bonneville Dam Populations		$360,000		$360,000
Small populations between Grays River and I-205	$2,500			$70,000
M&E Program development		$35,000		$8,000
BPA Budget Request Subtotal		$35,000		$493,000
Program Administration		$2,000		
GRAND TOTAL – Budget Request		$265,082		$1,144,000

1. A PSMFC Subcontract will be developed to assist with adult population monitoring at selected sites beginning in FFY2010.

Key:		
	Ongoing Project – Existing Budget	(yellow)
	FFY 2009 Budget Request – This Proposal	(green)
	FFY 2010 Projected/Estimated Cost	(blue)
	No Element/Action identified for completion.	(grey)

References

Allendorf, F.W., D. Bayles, D.L. Bottom, K.P. Currens, C.A. Frissell, D. Hankin, J.A. Lichatowich,W. Nehlsen, P.C. Trotter, and T.H. Williams. 1997. Prioritizing Pacific salmon stocks for conservation. Conservation Biology 11.1:140-152.

Ames J. and K. Adicks. 2003. Chum Salmon Supplementation: Ban or Boon?. Proc.of the Twenty-first Northeast Pacific Pink and Chum Salmon Workshop. Depart. Fisheries and Oceans. Vancouver, B.C. Canada.

Ames, J., G. Graves, and C. Weller. 2000. Summer chum salmon conservation initiative: An implementation plan to recover summer chum in the Hood Canal and Straight of Juan De Fuca Region. Washington Department of Fish and Wildlife and Point-No-Point Treaty Tribes.

Anderson, J. L., R. W. Hilborn, R. T. Lackey, and D. Ludwig. 2003. Watershed restoration—adaptive decision making in the face of uncertainty. Pages 203-232 in R. C. Wissmar and P. A. Bisson, editors. Strategies for restoring river ecosystems: sources of variability and uncertainty in natural and managed systems. American Fisheries Society, Bethesda, Maryland, USA.

Andrew and Geen. 1960. Sockeye and pink salmon production in relation to proposed dams in the Fraser River system. International Pacific Salmon Commission, Bulletin 11: page 110.

Anonymous-ICTRT. 2004. Viability Criteria: Summary of Approach and Preliminary Results. (Draft) July 8, 2004. Interior Columbia Basin Technical Recovery Team, NOAA, NMFS. 15 p.

Anonymous-ICTRT. 2005. Interior Columbia Basin TRT: Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. NW Fish. Sci. Center, USDC NOAA National Marine Fisheries Service, 2725 Montlake Blvd. E., Seattle WA 98112. 49 p.

Anonymous-ICTRT. 2007. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Review Draft. Interior Columbia Basin TRT, NW Fish. Sci. Center, USDC NOAA National Marine Fisheries Service, 2725 Montlake Blvd. E., Seattle WA 98112. 49 p.

Araki, H., Cooper, B., and Blouin, M.S. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science **318**:100-103.

Brenkman, S. J., S. C. Corbett, and E.C. Volk. 2007 Use of otolith chemistry and radiotelemetry to determine age-specific migratory patterns of anadromous bull trout in the Hoh River, Washington. Trans. Am. Fish. Soc. 136, 1-11

Bruya, K.J. 1981. The use of different gravel depths to enhance the spawning of chum salmon, *Oncorhynchus keta*. M.S. thesis. University of Washington, Seattle, Washington. 86 p.

Bryant, F.G. 1949. A survey of the Columbia River and its tributaries with special reference to the management of its fisheries resources. No. 2. Washington streams from the mouth of the Klickitat to and including the Klickitat River (Area I). U.S. Fish & Wildlife Service. Special Report No. 62. 110 pp. illus.

Burner, C.J. 1951. Characteristics of spawning nests of Columbia River salmon. Fisheries Bulletin, Fish and Wildlife service 61:97-110.

CBFWA (Columbia Basin Fish & Wildlife Authority). 2009. The Status of the Resource (SOTR) Draft Report. Columbia Basin Fish & Wildlife Authority. May 27, 2009. Portland, Oregon. (source: http://www.cbfwa.org/committee_main.cfm)

Chapman, D.W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Transactions of the American Fisheries Society 115:662-670.

Craig, J.A. and R.L. Hacker. 1940. The history and development of the fisheries of the Columbia River. U.S. Bureau of Fisheries. Bulletin 49(32): 133-215.

Crawford, B. A. and S. Rumsey. 2009. Guidance For Monitoring Recovery of Salmon and Steelhead Listed Under the Federal Endangered Species Act (Idaho, Oregon, and Washington). Draft – April 27, 2009. NOAA Fisheries Service – Northwest Region. 125 pages.

Crawford, B.A. (ed.) 2007. Washington State Framework for Monitoring Salmon Populations Listed under the Federal Endangered Species Act and Associated Freshwater Habitats. WA Gov. Forum on Monitoring Salmon Recovery and Watershed Health, Olympia WA.

Drivdahl, C. (ed.) 2006. 2006 State of Salmon in Watersheds. State of Washington Governor's Salmon Recovery Office. 101 p.

Ford, M.J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conserv. Biol. **16**(3): 815-825.

Fresh, K.L., R.D. Cardwell, B.P. Snyder, and E.O. Salo. 1980. Some hatchery strategies for reducing predation upon juvenile chum salmon (*Oncorhynchus keta*) in freshwater. Pages 79 - 89 *In:* Proceedings of the North American Aquaculture Symposium. Alaska Dept. Of Fish and Game. Anchorage, Alaska.

Fulton, L. A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River basin—past and present. Special Scientific Report—Fisheries 618.

Gardner, A. and West, S.A. 2004. Spite and the scale of competition. J. Evol. Biol. **17**:1195-1203.

Goodman, D. 2004. Salmon supplementation: demography, evolution, and risk assessment. *In* Propagated Fish in Resource Management. *Edited by* M.J. Hedrick, P. 2005. Large variance in reproductive success and the N_e/N ratio. Evolution **59**(7): 1596-1599.

Groot, C., and Margolis, L. 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver, B.C., Canada.

Hilborn, R. 1992. Institutional learning and spawning channels for sockeye salmon (Oncorhynchus nerka). Canadian Journal of Fisheries and Aquatic Sciences. 49:1126-1136.

Hillson, T. D. 2002. Re-Introduction of Lower Columbia River Chum Salmon into Duncan Creek Annual Report for 2002, Report to Bonneville Power Administration, Contract No. 00007373, Project No. 200105300, 63 electronic pages (BPA Report DOE/BP - 00007373 -1)

Hillson, T. D. 2003. Reintroduction of lower Columbia River chum salmon into Duncan Creek, 2002-03 annual report. *Prepared by* Washington Department of Fish and Wildlife for Bonneville Power Administration (BPA Report DOE/BP-00007373-2).

Hillson, T. D. 2004. Reintroduction of lower Columbia River chum salmon into Duncan Creek, 2003-04 annual report. *Prepared by* Washington Department of Fish and Wildlife for Bonneville Power Administration (BPA Report DOE/BP-00007373-4).

Hillson, T. D. 2007. Reintroduction of lower Columbia River chum salmon into Duncan Creek, 2005-06 annual report. *Prepared by* Washington Department of Fish and Wildlife for Bonneville Power Administration (BPA Report DOE/BP-00029512-1).

Howell, P., K. Jones, L. Scarnecchia, L. LaVoy, W. Kendra, and D. Ortmann. 1985. Lower Columbia River chum (wild and hatchery). Pages 528-537 *in* Stock Assessment of Columbia River Anadromous Salmonids; Volume I: Chinook, Coho, Chum and Sockeye Salmon Stock Summaries. Project No. 83-335, final report. Bonneville Power Administration.

HSRG (Hatchery Scientific Review Group). 2008a. Summary of HSRG Findings for Chum Populations in the Lower Columbia River and Gorge. March 11, 2008. Hatchery Scientific Review Group.

HSRG (Hatchery Scientific Review Group). 2008b. Review and Recommendations Chum Salmon Population and Related Hatchery Programs. Final. October 8, 2008 Hatchery Scientific Review Group http://www.hatcheryreform.us/mfs/reports/system/welcome_show.action

HSRG (Hatchery Scientific Review Group). 2008c. Columbia River Chinook Salmon Hatchery Analysis: Volume 1. (Draft) Hatchery Scientific Review Group. (218 pages) http://www.hatcheryreform.us/mfs/reports/system/welcome_show.action

Hymer, J. 1994. Estimating the Natural Spawning Chum Population in Hardy Creek 1957-93. Washington Department of Fisheries. Columbia River Laboratory Progress Report #94-11.

Johnson O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997 Status review of chum salmon from Washington, Oregon, and California. National Marine Fisheries Service. Seattle, Washington.

Johnson, R.C., R.J. Gerke, D.W. Heiser, R.F. Orrell, S.B. Mathews, and J.G. Olds. 1971. Pink and chum salmon investigations, 1969: supplementary progress report. Washington Department of Fisheries, Fisheries Management and Research Division, Olympia, Washington. 66 p.

Johnson, T.H., C. Weller and T. J. Tynan. 2003. Ongoing supplementation programs for summer chum salmon in the Hood Canal and Strait of Juan de Fuca regions of Washington State.

Proc.of the Twenty-first Northeast Pacific Pink and Chum Salmon Workshop. Depart. Fisheries and Oceans. Vancouver, B.C. Canada.

Kostow, K. (editor). 1995. Biennial report on the status of wild fish in Oregon. Internal Rep., Oreg. Dep. Fish Wildl., P.O. Box 59, Portland, OR 97207.

Lawson, P.W., E. Bjorkstedt, M. Chilcote, C. Huntington, J. Mills, K. Moore, T. Nickelson, G.H. Reeves, H.A. Stout & T.C. Wainwright. 2004. Identification of Historical Populations of Coho Salmon (Oncorhynchus Kisutch) in the Oregon Coast Evolutionarily Significant Unit. (Review Draft) Oregon-N. California Coast Tech. Recov. Team, USDC NOAA National Marine Fisheries Service, CZES Div., NW Fish. Sci. Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.

LCFRB. Lower Columbia Fish Recovery Board, 2004. Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan. http://www.lcfrb.gen.wa.us/recovery%20planning%20overview.htm

Marshall, Anne. 2001. Memo to Joe Hymer. Columbia River Main Stem Chum Genetic Sampling.

McClure, M., B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000a. A standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Cumulative Risk Initiative, Draft Report, Seattle, Washington. April 7.

McClure, B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000b. Revised Appendix B of standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. September.

McClure, M. M., B. L. Sanderson, E. E. Holmes, and C. E. Jordan. 2000c. A large-scale, multispecies risk assessment: anadromous salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. Submitted to Ecological Applications.McElhany P., M.H. Ruckelshaus, M.J. Ford, T.C.Wainright and E.P Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. NW Fisheries Science Center. - Seattle,WA : NOAA Fisheries Service, 2000. - p. 156 p.. - NOAA Tech. Memo. NMFS-NWFSC-42.

McElhany, P., T. Backman, C. Busack, S. Kolmes, J. Myers, D. Rawding, A. Steel, C. Steward, T. Whitesel, and C. Willis. 2004. Status Evaluation of salmon and steelhead populations in the Willamette and Lower Columbia River Basins. Willamette/Lower Columbia Technical Recovery Team. Northwest Fisheries Science Center, NOAA Fisheries, Seattle, Washington.

McElhany, P. 2005. Columbia River chum salmon ESU. *in* T. P. Good, R. S. Waples, and P. Adams, editors. Updated status of federally listed ESUs of west coast salmon and steelhead. NOAA, Seattle, WA.

McElhany, P., C. Busack, M. Chilcote, S. Kolmes, B. McIntosh, J. Myers, D. Rawding, A. Steel, C. Steward, D. Ward, T. Whitesel & C. Willis. 2006. Revised Viability Criteria for

Salmon and Steelhead in the Willamette and Lower Columbia Basins. April 1, 2006. Cons. Biol. Div., NW Fish. Sci. Center, USDC NOAA National Marine Fisheries Service, Seattle, WA 98112-2097.

McElhany, P., M. Chilcote, J. Myers, and R. Beamesderfer. 2007. Viability Status of Oregon Salmon and Steelhead Populations in the Willamette and Lower Columbia Basins Part 3: Columbia River Chum. Report prepared for the Oregon Department of Fish and Wildlife and the National Marine Fisheries Service.

Muldoon, A., J. Youngers, and E. Ollerenshaw. 2001. 2000 Oregon Lower Columbia River spawning ground survey results. Oregon Department of Fish and Wildlife. Columbia River Management, Clackamas, Oregon.

Neave, F., T. Yonemori, and R. Bakkala. 1976. Distribution and origin of chum salmon in offshore waters of the North Pacific Ocean. International North Pacific Fish Commission Bulletin 35:79 p.

Nickum, P.M. Mazik, J.G. Nickum, and D.D. MacKinlay. American Fisheries Society Symposium **44**. Bethesda, Maryland. pp. 217-232.

NOAA Fisheries Service. 2006. Pacific Coastal Salmon Recovery Fund Performance Goals, Measures, and Reporting Framework. - Seattle, WA : NOAA Fisheries Service, December 2006.

NOAA Fisheries Service. 2007. Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance. Seattle, WA. Northwest Region and Fisheries Science Center, May 2007.

NOAA Fisheries Service. 2008a. Draft Artificial Propagation of Pacific Salmon: Assessing Benefits and Risks and Recommendations for Planning and Operating Hatchery Programs. Salmon Recovery Division. - Portland, OR : US Dept. of Commerce NOAA's National Marine Fisheries Service.

NOAA Fisheries Service. 2008b. Cumulative effects analysis of the FCRPS Biological Opinion. Chapter 8 Effects Analysis for Salmonids. Section 8.9 Columbia River Chum Salmon. May 5, 2008.

North, J. M. Miller, J. Sewall, T. Jones, A. Dietrichs, and T. Miethe. 2006. Select Area Fishery Evaluation Project, Final Project Report, October 1993 – October 2005. Prepared for: U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

NPPC (Northwest Power Planning Council). 1984. The Columbia Basin Fish & Wildlife Program. Northwest Power Planning Council. Portland, Oregon.

NPPC (Northwest Power Planning Council). 1986. Council staff compilation of information on salmon and steelhead losses in the Columbia River basin. Northwest Power Planning Council. Portland, Oregon. (Cited in Chapman 1986)

Northwest Power Planning Council et al. 1990. Grays River Subbasin salmon and steelhead production plan. Washington Department of Fisheries, Olympia. 70 p.

ODFW (Oregon Department of Fish and Wildlife). 2009. Draft Oregon Lower Columbia River Recovery Plan for Salmon and Steelhead - Appendix 7-C: Columbia River Chum

Salmon Recovery Strategy for Oregon's Lower Columbia River Coastal Stratum Tributaries April 22, 2009. Salem, Oregon.

ODFW (Oregon Department of Fish and Wildlife). 2005. 2005 Oregon native fish status report. Volume II. Assessment methods and population results. Oregon Department of Fish and Wildlife. Salem, Oregon.

Otak, Inc. 2007. Columbia Springs chum salmon spawning channel conceptual design report. Submitted to Lower Columbia Fisheries Enhancement Group (LCFEG). Vancouver, WA. May 7. 2007. 10 Pages + Appendices. Prepared by Otak, Inc. Kirkland, WA.

PC Trask & Associates. 2007. Draft: Estimated benefits of Federal agency habitat projects in the Lower Columbia River and Estuary. Prepared for the Policy work Group of the FCRPS Remand. Attachment B.2.2-3.

PFMC (Pacific Fishery Management Council. 1979. Freshwater habitat, salmon produced, and escapement for natural spawning along the Pacific Coast of the United States. Report to the Anadromous Salmonid Environmental Task Force, Portland, Oregon.

Phelps, S.R., L.L. LeClair, S. Young, and H.L. Blankenship. 1994. Genetic diversity patterns of chum salmon in the Pacific Northwest. Canadian Journal of Fisheries and Aquatic Sciences. 51 (Supplement 1), 65-83.

Powers, P.D., and J.F. Osborn 1985. Analysis of barriers to upstream fish migration: an investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Final project report, part 4 of 4, Project 82-14. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Portland, Oregon. 120 p.

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press, Seattle, WA.

Rawding, D. and T. D. Hillson. 2003. Population estimates for chum salmon spawning in the Mainstem Columbia River, 2002. Project 2001-05300, 47 electronic pages, (BPA Report DOE/BP-00007373-3) http://www.efw.bpa.gov/Publications/A00007373-3.pdf

Rawding, D., T. Hillson, B. Glaser, K. Jenkins, and S. VanderPloeg. 2006. Abundance and Spawning Distribution of Chinook Salmon in Mill, Abernathy, and Germany Creeks during 2005. Wash. Dept. of Fish and Wild. Vancouver, WA. 37pp.

Rich, W.H. 1948. A survey of the Columbia River and its tributaries with special reference to the management of its fisheries resources. No. 1. Introduction. U.S. Fish & Wildlife Service. Special Report No. 51. 26 pp. illus.

Roler, R. 2002. Grays River Subbasin Summary *draft*. Washington Department of Fish and Wildlife. Prepared for the Northwest Power Planning Council.

Ruckelshaus, M.H., K.P. Currens, R.R. Fuerstenberg, W.H. Graeber, K. Rawson, N.J. Sands & J.B. Scott. 2002. Planning Ranges and Preliminary Guidelines for the Delisting and Recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit. USDC NOAA National Marine Fisheries Service, NW Fish. Sci. Center, 2725 Montlake Blvd. E., Seattle WA 98112. 17 p.

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands & J.B. Scott. 2006. Independent populations of Chinook salmon in Puget Sound. Tech. Memo: NMFS-NWFSC-78. Dept. Commer., USDC NOAA National Marine Fisheries Service, NW Fish. Sci. Center, 2725 Montlake Blvd. E., Seattle WA 98112. 125 p.

Rukhlov, F.N. 1969. 1982. The role of salmon production and the perspectives of its development in the Sakhalin region, p 99-103. In: B.R. Metcalf and R.A. Neve (editors). Proceedings of the North Pacific Aquaculture Symposium. Alaska Sea Grant Report 82-2.

Ryman, N., and Laikre, L. 1991. Effects of supportive breeding on the genetically effective population size. Conserv. Biol. **5**: 325-329.

Salo, E.O. 1991. Life history of chum salmon (*Oncorhynchus keta)*. Pages 231 - 310 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, Univ. British Columbia, Vancouver, British Columbia

Sano, S., and A. Nagasawa. 1958. Natural propagation of chum salmon, *Oncorhynchus keta*, in Memu River, Tokachi. Scientific Report of the Hokkaido Salmon Hatchery 12:1-19. (translation: Fish. Res. Bd. Canada Tranls. Ser. 198).

Schroder, S.L. 1973. Effects of density on the spawning success of chum salmon (*Oncorhynchus keta*) in an artificial spawning channel. M.S. Thesis, Univ. Washington, Seattle. 78 pp.

Schroder, S.L. 1977. Assessment of production of chum salmon fry from the Big Beef Creek spawning channel. Completion Rep. Anadromous Fish Project AFC-67. Fish. Res. Inst., Univ. Washington, FRI-UW-7718. 77pp.

Schroder, S.L. 2000. Monitoring and evaluation plan for Duncan Creek chum Salmon reintroduction plan. Washington Department of Fish and Wildlife, unpublished paper.

Schroder, S. and J. Ames. 2004. Summer chum conservation initiative: An Implementation plan to recover summer chum salmon in the Hood Canal and Strait of Juan de Fuca region. Supplemental Report No. 6, Washington Department of Fish and Wildlife.

Small, M.P., A.E. Frye, J.F. Von Bargen, and S.F. Young. 2006. Genetic Structure of chum salmon (Oncorhynchus keta) populations in the lower Columbia River: are chum salmon in Cascade tributaries remnant populations? Conservation Genetics 7:65-78.

Small M. P., Beacham T., Withler R. and Nelson R. J. 1998. Discriminating coho salmon (Oncorhynchus kisutch) populations within the Fraser River, British Columbia using microsatellite DNA markers, Mol. Ecol., 7, 141-155.

Small, M. P., J.F. Von Bargen, A.E. Frye, and S.F. Young. 2004. Population genetic structure in Lower Columbia River chum salmon (Oncorhynchus keta) inferred from microsatellite DNA. WDFW, (unpublished paper).

Small, M.P., Currens, K., Johnson, T.H., Frye, A.E., and J.F. Von Bargen. (unpublished manuscript) Impacts of supplementation: Genetic diversity in supplemented and unsupplemented populations of summer chum salmon (*Oncorhynchus keta*) in Puget Sound (Washington, USA) Molecular Genetics Laboratory, Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA, 98502, USA

Smith, H.M. 1895. Notes on the reconnaissance of the fisheries of the Pacific Coast of the United States in 1894. U.S. Fish Commission Bulletin 14:223-288. (Cited in Chapman 1986)

USACE (U.S. Army Corps of Engineers). 2009. 2008 Annual Fish Passage Report Columbia and Snake Rivers for salmon, steelhead, shad and lamprey. Prepared By: U.S. Army Engineer Districts: Portland and Walla Walla. 203 pages.

Volk, E.C., S.L. Schroder, and J.J. Grimm. 1999. Otolith thermal marking. Fisheries Research 43: 205-219.

Vigg, S. 2009. Potential biological benefits of the proposed property acquisition and habitat restoration at Woods Landing/Columbia Springs – to provide additional chum salmon spawning and a cold-water refuge for all summer and fall-migrating salmonids. Washington Department of Fish & Wildlife. Vancouver, WA.

Vigg, S. and M. Dennis (editors). 2009. Lower Columbia River (LCR) Fishery Management and Evaluation Plan (FMEP) and Coho Supplement Annual Report, 2008 and five-year comprehensive update – 2002 – 2007. March 5, 2009. Washington Department of Fish & Wildlife, Fish Program, Fish Management and ESA Divisions, Olympia, Washington. 64 pp.

Waples, R.S. 1991. Pacific Salmon, Oncorhynchus spp., and the Definition of "Species" Under the Endangered Species Act. Marine Fisheries Review 53: 11-22.

WDFW (Washington Department of Fish and Wildlife). 2008. Statewide Steelhead Management Plan: Statewide Policies, Strategies, and Actions. WA Dept. Fish & Wildlife, 600 Capitol Way N., Olympia WA 98501-1091. 42 p.

WDFW (Washington Department of Fish and Wildlife). 2004. Draft Grays River/Sea Resources chum salmon hatchery genetic management plan. WDFW. Olympia, Washington.

WDFW (Washington Department of Fish and Wildlife). 2004. Draft Washougal Hatchery Chum Salmon Program Hatchery Genetic Management Plan. WDFW. Olympia, Washington. Last Updated August 13, 2004

WDFW/ODFW (Washington and Oregon Departments of Fish and Wildlife). 2002. Columbia River Fish Runs and Fisheries, 1938-2002.

Yaffee, S., S. Schueller, S. Higgs, A. Dotzour and J. Wondolleck. 2004. Measuring Progress: An Evaluation Guide for Ecosystem and Community-Based Projects. Ecosystem Management Initiative, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI.

Appendix 1. Glossary of Terms.

(Primary source: Columbia River Hatchery Reform Project – Final Systemwide Report – Appendix F (HSRG 2008) unless otherwise cited)

Abundance | In the context of salmon recovery, abundance refers to the number of adult fish returning to spawn. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Adaptive Management | The process of adjusting management actions and/or directionsbased on new information. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Anadromous (anadromy) | Fish which hatch and rear in fresh water, migrate to the ocean to grow and mature, and return to fresh water to spawn.

Artificial production | A fish that is produced in a controlled environment, such as a hatchery. (contrast natural production)

Baseline Monitoring | In the context of recovery planning, baseline monitoring is done before implementation, in order to establish historical and/or current conditions against which progress (or lack of progress) can be measured. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Biogeographical Region | An area defined in terms of physical and habitat features, including topography and ecological variations, where groups of organisms have evolved in common. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Broodstock | Adult fish used by hatcheries to propagate the next generation of fish.

Contributing populations | Populations for which some restoration will be needed to achieve a stratum-wide average of medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery (LCFRB 2004 p. **7).**

Core populations | Populations that, historically, represented a substantial portion of the species abundance.

Compensatory Mortality | Refers to mortality that would have occurred for another reason. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Compliance Monitoring | Monitoring to determine whether a specific performance standard, environmental standard, regulation, or law is met. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Critical Uncertainties research | cause-effects research needed to address key assumptions in a particular Adaptive Management program – whether it be hydro, habitat, hatcheries or harvest. Using an adaptive management process, one would make the management decision with the necessary assumptions, but acknowledge the uncertainties (unanswered questions that effect the outcome) and have an RM&E strategy for getting the information to test the assumptions, in case the decision or action fails. (NOAA Fisheries Adaptive Management Guidance 2007).

Delisting Criteria (recovery criteria) | Criteria incorporated into ESA recovery plans describing conditions, in terms of both biological status and threats, that when met, would result in a determination that a species was no longer threatened or endangered and could be proposed for removal from the federal list of threatened and endangered species.

Delisting Criteria | Criteria incorporated into ESA recovery plans that define both biological viability (biological criteria) and alleviation of the causes for decline (threats criteria based on the five listing factors in ESA section 4[a][1]), and that, when met, would result in a determination that a species is no longer threatened or endangered and can be proposed for removal from the Federal list of threatened and endangered species. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Density-Independent Survival | A change in survival that is not influenced by the number of fish in the population. Generally speaking, most factors influencing survival after the smolt stage are assumed to be density independent. During the egg-to-smolt stage, the density of adults and juveniles can influence survival as a result of competition for limited habitat or other factors. For evaluation of survival gaps, estimates of survival changes resulting from actions affecting early life stages of salmon and steelhead are made under the assumption of low density. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Distinct population segment (DPS) | A listable entity under the ESA that meets tests of discreteness and significance according to USFWS and NOAA Fisheries policy. A population is considered distinct (and hence a “species” for purposes of conservation under the ESA) if it is discrete from and significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics, it occupies an unusual or unique ecological setting, or its loss would represent a significant gap in the species’ range. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Diversity | All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include anadromy vs. lifelong residence in freshwater, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, molecular genetic characteristics, etc. (NOAA Fisheries 2008 FCRPS Biological Opinion)

DPS Distinct Population Segment. | A group of steelhead trout that is (1) substantially reproductively isolated from other conspecific units and (2) represents an important component of the evolutionary legacy of the species.

EDT Ecosystem Diagnosis and Treatment. | A science-based approach to formalizing and analyzing actions to improve the sustainability and production of migratory salmon. The approach integrates the quality and quantity of habitat across the salmon life cycle. It estimates the ability of the environment to support a population in terms of abundance, productivity, and life history diversity.

Effectiveness monitoring | evaluates whether the management actions achieved their direct effect or goal. Success may be measured against “reference areas,” “baseline conditions,” or “desired future conditions.” Effectiveness monitoring can be implemented at the scale of single actions, suites of actions across space, or for an entire strategy consisting of a diversity of actions in a single place. In the example of exclusionary fencing protecting a riparian area, the effectiveness monitoring indicators would be an assessment of the project’s effect on the riparian habitat, given that the project was properly implemented and in compliance with expected impact. Thus an appropriate metric would be riparian vegetation recovery, since this is expected to be an effect of excluding livestock from the riparian corridor. The components of effectiveness monitoring can be parsed out into implementation, compliance, effectiveness, and validation (Adaptive Management Guidance; NMFS 2007).

Effectiveness Monitoring | Monitoring set up to test cause-and-effect hypotheses about recovery actions: Did the management actions achieve their direct effect or goal? For example, did fencing a riparian area to exclude livestock result in recovery of riparian vegetation? (NOAA Fisheries 2008 FCRPS Biological Opinion)

ESA recovery plan | A plan to recover a species listed as threatened or endangered under the U.S. Endangered Species Act (ESA). The ESA requires that recovery plans, to the extent practicable, incorporate (1) objective, measurable criteria that, when met, would result in a determination that the species is no longer threatened or endangered; (2) site-specific management actions that may be necessary to achieve the plan's goals; and (3) estimates of the time required and costs to implement recovery actions. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Endangered Species Act (ESA). | A 1973 act of congress mandating that endangered and threatened species of fish, wildlife, and plants be protected and restored.

Escapement | The portion of a run that is not harvested and escapes to natural or artificial spawning areas.

Evolutionarily significant unit (ESU) | A group of Pacific salmon or steelhead trout that is (1) substantially reproductively isolated from other conspecific units and (2) represents an important component of the evolutionary legacy of the species. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Factors For Decline | Five general categories of causes for decline of a species, listed in the Endangered Species Act section 4(a)(1)(b): (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Fingerlings | A young fish in its first or second year of life.

Fitness (Individual) | The mean number of adult, or sexually mature offspring, produced by an individual organism. Individual fitness is the multiplicative product of two probabilistic components: (1) viability fitness, which measures the probability that an individual will survive to sexualmaturity from zygote formation, and (2) reproductive fitness, the expected number of sexually mature offspring that the individual will produce after attaining sexual maturity. Individual fitness is a function of the individual’s genotype (genetic makeup at zygote formation) and the environments to which that organism is exposed throughout its lifetime.

Fitness (Population) | The mean fitness of all individual within a population that interbreed when mature within a common environment.

Fry | A stage of development in young salmon or trout. During this stage the fish is usually less than one year old, has absorbed its yolk sac, is rearing in the stream, and is between the alevin and parr stage of development.

Functionally Extirpated | Describes a species that has been extirpated from an area; although a few individuals may occasionally be found, they are not thoughtto constitute a population. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Genetic legacy populations | A population that has had minimal influence from non-endemic fish due to artificial propagation activities, or may exhibit important life history characteristics that are no longer found throughout the ESU.

Genetic legacy populations | "*Populations are considered genetic legacies for two reasons. The population may have had minimal influence from nonendemic fish due to artificial propagation activities, or the population may exhibit important life-history characteristics that are no longer found throughout much of their historical range in the ESU. Populations that are determined to be genetic legacies should be considered for prioritization in recovery efforts because they retain the most intact representatives of the genetic character of the ESU. Furthermore, populations that have maintained their genetic integrity should have retained a high degree of adaptation to local watershed conditions and are therefore more likely to achieve viable salmonid population (VSP) sustainability than are newly introduced or domesticated populations.*" McElhany et al. (2003).

Healthy and Harvestable population | A self-sustaining naturally produced stock that has attained a status that will support meaningful retention and non-retention fisheries on an annual basis (Washington State Steelhead Management Plan ; 2008 p. 34).

Healthy Stock | A wild stock that has sufficient viable salmonid parameters (VSP): abundance, productivity, diversity and spatial structure to be resilient through environmental fluctuations, to perform natural ecological functions in freshwater and marine systems, provide related cultural values to society, and sustain tribal and recreational fisheries (Washington State Steelhead Management Plan ; 2008 p. 34).

Homing | The ability of a salmon or steelhead to correctly identify and return to their natal stream, following maturation at sea.

Implementation monitoring | Monitoring to determine whether an activity was performed and/or completed as planned. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Imprinting | The physiological and behavioral process by which migratory fish assimilate environmental cues to aid their return to their stream of origin as adults.

Independent and Dependent populations | Classification system used by the Oregon coastal coho TRT and the Central California Coast TRT (Lawson et al. 2004):

> **"Functionally Independent populations:** high-persistence populations whose dynamics or extinction risk over 100-year time frame is not substantially altered by exchanges of individuals with other populations. These populations are net "donor" populations that may provide migrants for other types of populations. This category is analogous to the "independent populations" of McElhany et al. (2000)."

> **“Potentially Independent populations:** high-persistence populations whose population dynamics may be substantially influenced by periodic immigration from other populations. In the event of the decline or disappearance of migrants from other populations, a Potentially Independent population could become a Functionally Independent population**.”**
>
> **“Dependent populations:** low-persistence populations that rely upon immigration from other populations. Without these inputs, Dependent populations would have a lower likelihood of persisting over 100 years. They are “receiving” populations that are dependent on sufficient immigration from surrounding populations to persist.”

Independent population | Any collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Indicator | A variable used to forecast the value or change in the value of another variable. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Intrinsic Productivity | The average of adjusted recruits per spawner estimates for only those brood years with the lowest spawner abundance levels. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Integrated hatchery program | A hatchery program with the intent for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild.

Lambda | Also known as Population growth rate, or the rate at which the number of fish in a population increases or decreases. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Legacy Effects | Impacts from past activities (usually a land use) that continue to affect a stream or watershed in the present day. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Limiting Factor | Physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) experienced by the fish at the population, intermediate (e.g., stratum or major population grouping), or ESU levels that result in reductions in viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity). Key limiting factors are those with the greatest impacts on a population’s ability to reach its desired status. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Local adaptation | The evolutionary product of natural selection for a population that inhabits and reproduces within a specific environment for many generations until a genetic-environmental equilibrium is established where the phenotypic means of the population equal, or approximately equal stochastically, the phenotypic optima that confer maximum fitness for the species in the specified environment.

Major dams | Large hydro-electric projects developed by Federal agencies within the Pacific Northwest. Twenty-nine major dams are in the Columbia River Basin. Two dams are in the Rogue River Basin. A total of 31 dams comprise the Federal Power System. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Major population group (MPG) | A group of salmonid populations that are geographically and genetically cohesive. The MPG is a level of organization between demographically independent populations and the ESU. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Major Population Grouping (MPG). | An aggregate of independent populations within an ESU or DPS that share similar genetic, ecological, and spatial characteristics.

Management unit | A geographic area defined for recovery planning purposes on the basis of state, tribal or local jurisdictional boundaries that encompass all or a portion of the range of a listed species, ESU, or DPS.

Metric | A measurement that quantifies a characteristic of a situation or process, e.g., the number of natural-origin salmon returning to spawn to a specific location is a metric for population abundance (NOAA Fisheries Adaptive Management Guidance 2007).

Natal stream | Stream of origin.

Natural production | A fish that is produced by parents spawning in a stream or lakebed, as opposed to a controlled environment such as a hatchery. (contrast artificial production)

Natural Recruitment | The stage at which a juvenile has survived long enough to become part of (i.e., recruited into) a population or an exploitable segment of a population.

Outmigration | The downstream migration of fish toward the ocean.

Parr | The developmental life stage of salmon and trout between alevin and smolt when the young have developed parr marks and are actively feeding in fresh water.

Primary population | one that must demonstrate low risk of extinction in order to recover the MPG and ESU. The statewide FORUM Framework that identifies a set of the most important populations, including at least one from each MPG, for monitoring – a total of 28 major population groups containing a 86 primary populations for chinook, coho, chum, and steelhead (Crawford [ed.] 2007). **|** Primary populations are those that would be restored to high or "high+" viability. At least two populations per strata must be at high or better viability to meet recommended TRT criteria. Primary populations typically, but not always, include those of high significance and medium viability. In several instances, populations with low or very low current viability were designated as primary populations in order to achieve viable strata and ESU conditions (LCFRB 2004 p. 5-7).

Population bottlenecks | The most significant limiting factors currently impeding a population from reaching its desired status. Bottlenecks result in the greatest relative reductions in abundance, productivity, spatial distribution, or diversity and are defined by considering viability impairment across limiting life stages and limiting factors. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Productivity | A measure of a population's ability to sustain itself or its ability to rebound from low numbers. The terms "population growth rate" and "population productivity" are interchangeable when referring to measures of population production over an entire life cycle. Can be expressed as the number of recruits (adults) per spawner or the number of smolts per spawner. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Quasi-Extinction Threshold (QET) | This is the point at which a population has become too small to reliably reproduce itself, even though there may be a few fish remaining. Since there is debate about the exact population level at which this condition occurs, several possible levels (50, 30, 10, 1) are considered. Results from short-term quasi-extinction probability modeling are used to help assess near-term (24-year) extinction risk. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Reasonable and Prudent Alternative RPA) | Recommended alternative actions identified during formal consultation that can be implemented in a manner consistent with the purposes of the action, that can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, that are economically and technologically feasible, and that the Service believes would avoid the likelihood of jeopardizing the continued existence of the listed species or the destruction or adverse modification of designated critical habitat. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Recovery goals | Goals incorporated into a locally developed recovery plan. These goals may go beyond the requirements of ESA de-listing by including other legislative mandates or social values. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Recovery strategy | A statement that identifies the assumptions and logic—the rationale—for the species' recovery program. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Recruits per spawner | Generally, a population would be deemed to be "trending toward recovery" if average population growth rates (or productivities) are expected to be greater than 1.0. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Recruitment | The number of fish that enter the exploitable stock and become susceptible to fishing due to growth and/or migration.

Recruits | The total number of fish of a specific stock available at a particular stage of their life history.

Recruits per spawner | The number of adult fish returning to an area per the number of fish that spawned the year before.

Redd | A salmon or steelhead spawning nest in gravel in which eggs are deposited.

Reintroduction | a Recovery Goal to reestablish LCR chum populations into habitats within the Columbia River ESU that the species has been functionally extirpated – using the best-available locally-adapted genetic stock (As defined in this proposal).

Salmon Stronghold Basins | the healthiest salmon stronghold river basins in North America (Wild Salmon Center web site. http://wildsalmoncenter.org/index.php)..

Salmon Protected Area (SPA) | a legally-protected, geographically-determined area encompassing a watershed and associated land, habitat for native salmon, trout or char. The area may be under federal, state/regional, or private ownership. In an SPA there is sufficient protected habitat to ensure the health of native salmon stocks. Land and water resources are managed primarily for wild salmon reproduction, and fish harvest programs emphasize native salmon conservation (Wild Salmon Center web site. http://wildsalmoncenter.org/index.php).

SAR | Smolt to adult return rate.

Segregated hatchery program | A hatchery program with the intent for the hatchery population to represent a distinct population that is reproductively isolated from naturally-spawning populations.

Smolt | The salmonid or trout developmental life stage between parr and adult, which the juvenile is at least one year old and has adapted to the marine environment.

Spatial structure | The geographic distribution of a population or the populations in an ESU. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Stabilizing population | One that would be maintained at current levels (likely to be low viability). Stabilizing populations might include those where significance is low, feasibility is low, and uncertainty is high (LCFRB 2004).

Status Monitoring | Status monitoring is used to characterize existing or undisturbed conditions and to establish a baseline for future comparisons. The intent of status monitoring is to capture temporal and spatial variability in the parameters of interest. (NOAA Adaptive Management Guidance 2007).

Stratum/major population group | An aggregate of independent populations within an ESU that share similar genetic and spatial characteristics. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Stray | A natural phenomena of some adult spawners not returning to their natal stream, but entering and spawning in some other stream.

Stronghold population | a wild salmon population that has maintained its genetic integrity within a specific geographic spawning area (e.g., stream) within an ESU – that could be used for reintroduction into adjacent local areas where stocks have been functionally extirpated.

Supplementation | an implementation strategy to achieve the goals of chum salmon reintroduction and recovery in the Columbia River ESU (As defined in this proposal).

Supplementation hatchery | A means to boost population abundance in threatened populations while minimizing risks from domestication (Ford 2002; Goodman 2004). | In supplementation programs, hatchery brood stocks are drawn from a portion of in-river spawners and the offspring are raised in hatcheries for release into the wild. Upon return, some or all hatchery-origin offspring are allowed to spawn in natural spawning areas (Small et al. 2009 Manuscript).

Supplementation strategy | A means to achieve a reintroduction recovery goal for functionally extirpated local populations in functioning or restored habitats within the Columbia River chum ESU – using a wild donor broodstock with the closest genetic characteristics to the historical population (As defined in this proposal). The following alternative methods can be used to implement the supplementation strategy:

(1) Transport and release live adult chum male and female spawners into the selected spawning habitat;
(2) Fertilize chum eggs in a hatchery and put into RSIs in selected habitats – for subsequent *in-situ* incubation, hatching, and volitional release;
(3) Fertilize chum eggs in a hatchery and upon hatching release fry into the selected rearing habitat;

(4) Fertilize chum eggs in a hatchery and upon hatching feed the fry to a specific size before releasing into the selected rearing habitat; and
(5) Natural recolonization by adult spawners into restored spawning habitat or constructed spawning channels.

Threats | Human activities or natural events (e.g., road building, floodplain development, fish harvest, hatchery influences, volcanoes) that cause or contribute to limiting factors. Threats may exist in the present or be likely to occur in the future. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Trend Monitoring | Trend monitoring involves measurements taken at regular time or space intervals to assess the long-term or large-scale trend in a particular parameter. The measurements are usually not taken specifically to evaluate management practices; they serve instead to describe changes in the parameter over time or space. (NOAA Adaptive Management Guidance 2007).

Validation Monitoring | Validation monitoring is research to verify the basic assumptions behind effectiveness monitoring and models. Validation monitoring is used to assess the assumed linkage between compliance and effectiveness monitoring indicators, and the assumed linkages between the effectiveness monitoring and the management objectives. In the fencing example, the validation monitoring indicators would be an assessment of two things: first that livestock exclusion results in riparian vegetation recovery so that the latter can be used as a cause-and-effect metric for the former; and second that riparian vegetation recovery results in water temperature reduction and sediment-delivery reduction, the ultimate indirect intent of the initial management action implementation. (NOAA Adaptive Management Guidance 2007).

Viability criteria | Criteria defined by NOAA Fisheries-appointed Technical Recovery Teams based on the biological parameters of abundance, productivity, spatial structure, and diversity, which describe a viable salmonid population (VSP) (an independent population with a negligible risk of extinction over a 100-year time frame) and which describe a general framework for how many and which populations within an ESU should be at a particular status for the ESU to have an acceptably low risk of extinction. See SCA Section 7.3 for a discussion of how TRT information is considered in these Biological Opinions. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Viable salmonid population | One that has a negligible risk of extinction over 100 years. Viable salmonid populations are described in terms of the four VSP parameters (NOAA Adaptive Management Guidance 2007). | An independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year time frame (McElhany et al. 2000).

Viable salmonid population (VSP) | An independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame. Viability at the independent population scale is evaluated based on the parameters of abundance, productivity, spatial structure, and diversity. (NOAA Fisheries 2008 FCRPS Biological Opinion)

VSP Parameters | Abundance, productivity, spatial structure, and diversity. These describe characteristics of salmonid populations that are useful in evaluating population viability. See NOAA Technical Memorandum NMFS-NWFSC-42, "Viable salmonid populations and the recovery of evolutionarily significant units," McElhany et al., June 2000. (NOAA Fisheries 2008 FCRPS Biological Opinion)

Wild fish | Any fish not supplied by a fish hatchery.

Appendix 2. Justification for chum reintroduction into the LCR using the WDFW supplementation strategy.

The following points are critical for the understanding the WDFW's reintroduction and supplementation strategy that is central to this proposal:

(1) Chum salmon are functionally extirpated from nearly all Oregon LCR tributaries (ODFW 2009); furthermore, nearly all Washington-side local chum salmon populations are severely diminished. Therefore, nearly all local populations of chum salmon in the LCR are currently at such depleted levels that supplementation would be beneficial; the real question is where to start.

(2) Harvest is currently not significantly impacting the extant LCR chum populations in Washington {WDFW-FMEP (2009); NOAA Fisheries FCRPS Biological Opinion (NMFS 2008, Section 8.9)}. Refer to WDFW Specific Response #1 for details.

(3) Viable chum populations do not exist in most tributary areas where habitat restoration is needed or ongoing; i.e., target habitat is currently degraded and unseeded or recently restored and unseeded. We <u>are</u> proposing concurrent chum reintroduction and high-impact habitat restoration as our primary strategy.

We use the term **reintroduction** in the context of a Recovery Goal for LCR chum in habitats that they have been functionally extirpated. We define **supplementation** as an implementation strategy to achieve the goals of reintroduction and recovery. **Artificial production** is a tool that can be used in various ways to implement a supplementation strategy. WDFW plans to incorporate at least five alternative methods to implement supplementation strategies in conjunction with habitat restoration:

(1) Transport and release live adult chum salmon spawners into the selected spawning habitat;

(2) Fertilize eggs in a hatchery and put into RSIs in selected habitats – for subsequent *in-situ* incubation, hatching, and volitional release;

(3) Fertilize eggs in a hatchery and upon hatching release fry into the selected rearing habitat;

(4) Fertilize eggs in a hatchery and upon hatching feed the fry to a specific size before releasing into the selected rearing habitat; and

(5) Natural recolonization by adult spawners into restored spawning habitat or constructed spawning channels.

Refer to the decision tree below (Figure 2.1) – with respect to how supplementation strategies would be implemented.

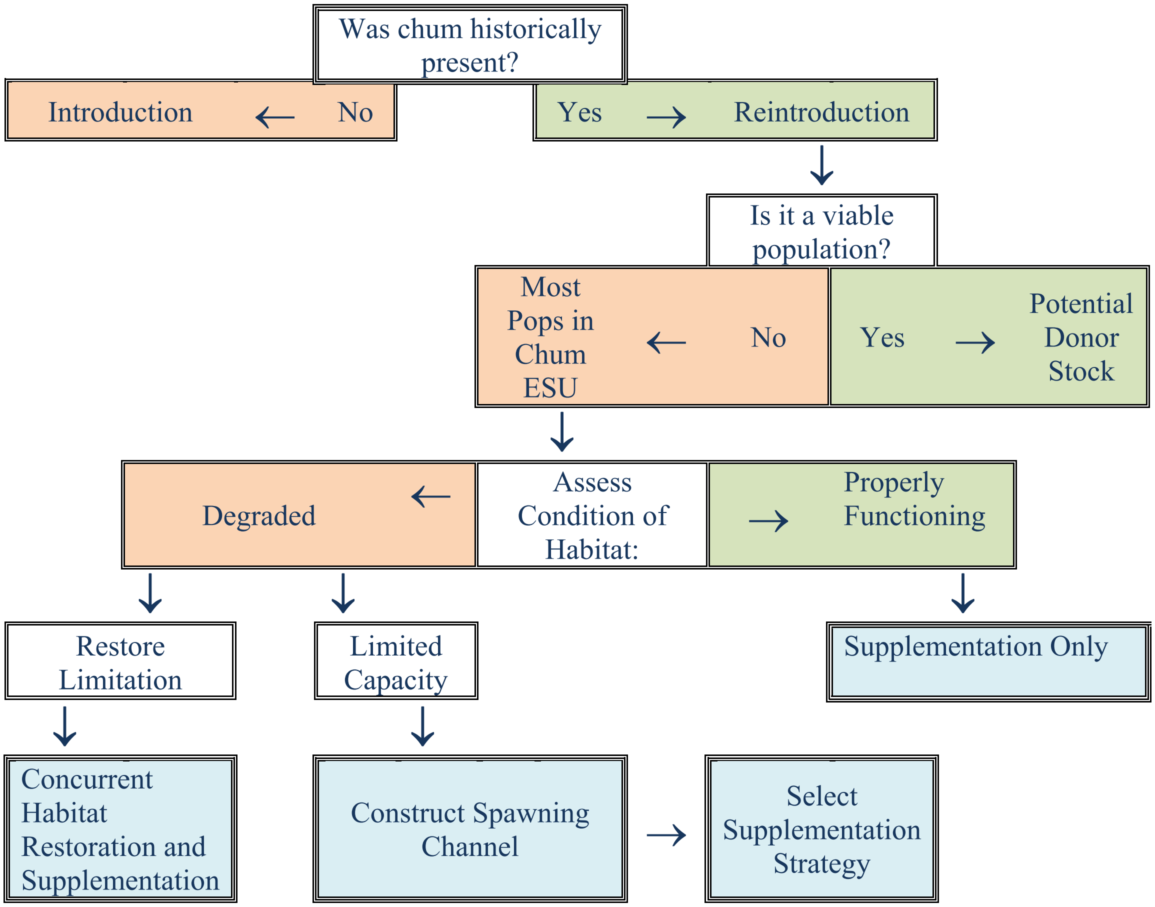


Figure 2.1. Decision tree for implementing LCR chum salmon supplementation strategies.

The HSRG notes that 13 of 16 historical populations of Columbia River chum salmon are severely depressed even though Washington's Lower Columbia River Recovery Plan (LCFRB 2004) indicates habitat is available to support much larger populations. Under current habitat conditions, managers estimate an ESU abundance of 24,000 chum salmon can be supported. With habitat improvements to tributaries, an estimated ESU abundance of 115,000 chum salmon is possible (HSRG 2008a).

The LCFRB Recovery Plan (2004) supports supplementation as a rebuilding strategy:

- "*using hatchery supplementation to rebuild depressed natural runs as a temporary measure until habitat or passage improvements are completed…*"
- "*In some cases, hatchery influences are minimal and wild fish may be used in a hatchery to jump start natural populations through supplementation in some areas where habitat restoration has been effective (e.g. Grays River and Duncan Creek chum).*"

We will further delineate reintroduction and supplementation under Objective 3 of our proposal: Develop a supplementation/reintroduction strategy for Lower Columbia River chum salmon. These terms have been defined for summer chum under the Summer Chum Salmon Conservation Initiative (SCSCI) - An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca Region (2000) and this plan will likely be used to guide our development of the decision making process on supplementation /reintroduction.

Deciding when to reintroduce or supplement a summer chum population requires careful consideration of the need and consequences of such an action. Supplementation should only be done to rebuild a population when that population is at risk of extinction, or to develop a brood stock for reintroduction (page 108 of SCSCI 2000).

Using this practical definition and looking at recent escapement levels for Lower Columbia River chum salmon (Table 2.1), it can be argued that all populations, except the Grays population, would be candidates for supplementation based on extinction risk. Also, at these low population levels it is unlikely that just habitat restoration would be sufficient to stop/reverse the decline. At this stage of the project, we are only proposing to continue two supplementation programs, Grays River and at Duncan Creek. Duncan Creek was initially a combination of supplementation (via fed-fry) and reintroduction (direct adult plants) but budget cuts in F0FY 08 have reduced it to only reintroduction and M&E. The Grays River program would continue under this project as a source of broodstock/fed-fry for reintroduction programs in both Washington and Oregon and to supplement the Grays River population.

A fully developed and reviewed supplementation/ reintroduction plan for Lower Columbia River chum salmon will be produced under this project. However, it is likely we will follow the lead of the SCSCI (2000) and the objectives in developing our supplementation/reintroduction projects will be to:

1) rebuild chum populations at risk of extinction,
2) restore chum to streams where a viable spawning population no longer exists,
3) maintain or increase chum populations of selected streams to a level that will allow their use as broodstock donors for streams where chum population have been lost, and
4) avoid and reduce the risk of deleterious genetic and ecological effects.

Measuring and documenting hatchery/wild impacts will be addressed under the Population and Evaluation Plan (Objective 4) of our proposal. All program-origin fry will be marked allowing identification when recovered as carcasses in commercial fisheries, on spawning ground surveys or at hatchery racks, via otolith analysis. Guidelines relating to hatchery origin adults interacting with native spawners recently released by the Hatchery Scientific Review Group for chum salmon will likely be incorporated into our plan. Preliminary data on the proportion of hatchery-origin spawners recovered during spawning ground surveys, Grays River basin are presented in Table 2.2.

Table 2.1. Chum salmon abundance estimates for Southwest Washington and LCR Tributaries, 2002-2007 (source: Todd Hillson and Julie Henning, WDFW).

River or Tributary	2002	2003	2004	2005	2006	2007
Grays River	11,713	16,667	14,367	4,195	6,115	3,832
Skamokawa Creek	159	152	31	24	153	55
Elochoman River	13	26	3	11	306	4
Mill Creek	0	0	0	0	---	---
Abernathy Creek	33	40	0	0	---	---
Germany Creek	38	76	6	2	1	2
Cowlitz River	---	15	8	13	8	5
Coweeman River	---	---	0	---	---	---
Kalama River	---	2	1	---	---	---
Lewis River	28	86	15	8	5	31
EF Lewis River	3	2	3	3	0	
Hatchery outlet Creek	30	1	0	6	3	0
Josephs Creek	12	10	0	0	5	1
Mainstem- I 205	3,468	2,844	2,102	1,009	862	544
Washougal	24	7	0	0	0	---
Lacamas Creek	21	28	25	0	0	1
Mainstem- St Cloud	---	167	104	92	173	9
Mainstem- Multnomah	1,267	1,130	665	211	313	115
Mainstem- Horsetail	---	---	106	40	63	17
Mainstem- Ives	4,232	667	336	229	348	145
Duncan Creek	13	13	2	7	42	9
Woodard Creek	0	0	0	0	0	0
Hardy Creek	343	392	49	73	104	14
Hamilton Creek	1,794	863	568	258	482	123
Greenleaf Creek	106	0	1	---	---	

Note: Several population estimation methods were used to create the data in this table. Readers should use caution when comparing between years and locations especially for areas with low abundance since many are AUC, peak counts or counts from presence absence surveys without error/bias estimates.

There has been extensive work on hatchery and wild chum fry interactions/impacts in the Hood Canal. They found that chum fry occupy different areas and utilize different prey items at different sizes. Because of this, we expect little direct competition between naturally produced fry (start emigration at 35-40 mm) and hatchery origin fed-fry (start emigration at 55-60 mm) in streams. If unfed fry are released they may have a greater likelihood for interaction with native fry chum since they are of similar size, and likely use the same areas for foraging during migration.

Table 2.2. Percent hatchery-origin spawners recovered during spawning ground surveys, Grays River basin.

Year	# Otoliths decoded	# Natural origin (no thermal mark)	# Hatchery origin (thermally marked)	% Hatchery origin	Spawner population estimate
2003	737	665	72	9.77%	16,667
2004	648	638	50	7.72%	14,364
2005	--	--	--	--	--
2006	906	826	80	8.80%	6,115

Otoliths from the 2005 spawning season have not been decoded due to lack of funding.

One could question if the benefits of supplementation would be reduced by predaton on chum (fry) by coho, Chinook, steelhead, cutthroat trout, etc?" There has been no chum specific predation research in the Lower Columbia River to answer this question. WDFW has taken steps though to reduce the likelihood of this occurring in streams where both hatchery chum and larger yearling sized hatchery smolts are produced. This has been done primarily through time of release, hatchery chum are released and given a reasonable time to clear the system before yearling smolts are released. Since chum fry typically immediately migrate, this practice should reduce/eliminate interactions in the streams. To what extent predation occurs on hatchery origin chum fry in the estuary and in near-shore areas is unknown but assumed to be small.

To date, little information is known about returns to Bonneville area spawning grounds of Duncan Creek project hatchery-origin adults. We are still waiting for complete decoding of otoliths recovered during the falls of 2007 and 2008. As a result, we only have one complete brood year return to look at, the last adults expected from the 2001 brood year returned fall of 2006. Twenty-three females were spawned in 2001 to produce 45,046 hatchery fed-fry that were released in spring of 2002, 67 adults were estimated to have returned from this release (all in 2005 as age-4 adults) resulting in a fry-to-adult survival rate of 0.15%.

Information on returns resulting from the adult supplementation at Duncan Creek is not available at this time. Strontium marking of fry produced in the channels was not initiated until 2004 due to permitting issues. The first year of adult returns from 2004 outmigrants would have been 2006, age-3 adults, and no strontium marked otoliths were recover that year. However the sample size was extremely small, only 14 of the 456 otoliths recovered came from age-3 adults. Similarly to what was detailed above, otoliths recovered in 2007 and 2008 have not yet been examined for the presence/absence of a strontium mark.

Appendix 3. HSRG (2008a) strategy for implementing conservation hatchery programs to rebuild LCR chum populations.

The framework for a conservation strategy is defined through recent state and federal recovery planning efforts. The managers want at least two chum populations within each stratum to meet the standards of a Primary population.

The HSRG reviewed options for chum conservation in the lower Columbia River in the context of conservation goals for other salmon and steelhead ESUs as well as the objectives of fisheries managers for Chinook and coho harvest. Based on this broader context, the HSRG notes that conservation goals for the chum population in the Youngs Bay tributaries (as a Primary population) may be in conflict with conservation and harvest goals for coho salmon in this area. Timing of intensive gill-net fisheries in Youngs Bay to fully harvest hatchery-origin coho overlaps with the return of adult chum salmon. Furthermore, the release of large numbers of juvenile Chinook and coho salmon from net pens in this area may also cause excessive predation on migrant chum fry. Other chum populations in the Coast stratum are more likely to achieve the status of a Primary population in a manner that is compatible with the managers' goals for Chinook and coho.

Harvest of chum salmon is incidental, occurring primarily in the lower Columbia River commercial coho fishery. Sport harvest of chum in the Columbia River and tributaries has been closed since 1992 in Oregon and 1995 in Washington. The presumption is that chum salmon are not harvested in the ocean or in the Columbia River above Bonneville Dam. Fishery managers set a 5% maximum incidental harvest mortality on Columbia River chum. Recent harvest rates are reported to have averaged about 1.6% annually (FCRPS BiOp). Because of the potential for misidentification of chum caught in intensive coho fisheries, the HSRG recommends field confirmation of this harvest rate.

Chum hatchery programs have been associated with increased abundance of natural chum populations, most notably summer chum in Puget Sound. Hatchery chum populations are less likely to be affected by domestication given their short-term culture. There are currently two hatchery conservation programs for chum salmon in the Columbia Basin, Grays River/Chinook River (WA) in the Coast stratum, and Duncan Creek (WA) in the Gorge stratum (Table 4).

The HSRG notes that 13 of 16 historical populations of Columbia River chum salmon are severely depressed even though Washington's Lower Columbia River Recovery Plan indicates habitat is available to support much larger populations. Under current habitat conditions, managers estimate an ESU abundance of 24,000 chum salmon can be supported. With habitat improvements to tributaries, an estimated ESU abundance of 115,000 chum salmon is possible.

Hatchery intervention can reduce demographic risk by boosting abundance. Additional conservation propagation programs should be promptly initiated within each of the ESU's three geographic strata to reduce this risk. Existing and candidate populations for hatchery conservation programs are identified in Table 4. Chum conservation programs can be rapidly implemented at existing facilities at modest cost. Programs should be sized at 100,000 to 200,000 fry releases. These programs should last up to three generations. Broodstock should be selected from the target population, or in the case of reintroductions, from the most suitable available population.

The need for hatchery intervention has been recognized by others and funding appears to be available to pursue chum hatchery programs following more detailed planning. We recommend planning be immediately initiated leading to one or two programs for initial implementation in each stratum. The planning process should also include the development of a set of hypotheses regarding the likely causes of the decline of chum. Based on these hypotheses, the role and objectives of conservation hatcheries in a comprehensive recovery plan should be defined. Additional reintroduction or other conservation programs could then be considered based on monitoring and evaluation results.

In summary, the use of chum conservation programs should be viewed as an important short-term risk management strategy to preserve the genetic legacy of depressed chum populations. Managers also need to better understand what has caused the overall chum decline and what ecological and/or demographic factors are continuing to keep the ESU at such low abundance levels given the apparent available habitat capacity and propensity for salmon populations to be highly productive at low abundances. Managers should avoid maintaining this ESU only through artificial propagation due to long-term hatchery risks of domestication and fitness loss.

Table 4. Existing and HSRG-proposed propagation programs for conservation and recovery of chum salmon.

Populations	Existing Conservation Programs	Potential Conservation Programs	Potential Control Populations
Coast Stratum			
Grays/Chinook (WA)	Grays/Chinook		
Elochoman (WA)		Elochoman	
Mill/Abernathy/Germany (WA)		Abernathy	Mill/Germany
Youngs Bay Tribs. (OR)			Klaskanine/Youngs
Big Creek (OR)		Big Creek	
Clatskanie (OR)		Clatskanie	
Scappoose (OR)			Scappoose
Cascade Stratum			
Cowlitz (WA)			Cowlitz
Kalama (WA)			Kalama
Lewis (WA)		Lewis	
Salmon (WA)			Salmon
Washougal (WA)		Washougal	
Clackamas (OR)			Clackamas
Sandy (OR)		Sandy	
Gorge Stratum			
Lower Gorge Tribs.	Duncan		Hamilton/Hardy
Upper Gorge Tribs.		Wind, White Salmon	Hood

Appendix 4. Draft Columbia River Chum Salmon Recovery Strategy for Oregon's Lower Columbia River Coastal Stratum Tributaries April 22, 2009. (excerpt from ODFW 2009).

The over-arching goal of Oregon's recovery strategy is to develop a science-based approach utilizing the best available technical information to reduce risk, ensure success, and inform adaptive management. To increase the likelihood for success, Oregon has conducted an extensive review of existing scientific literature, incorporated recommendations from the Hatchery Scientific Review Group (HSRG), and evaluated and discussed various aspects of habitat requirements, reintroduction, artificial propagation, and population dynamics with fishery managers with expertise in these fields. We focused the scope of our technical review based on 8 key elements that served as the foundation for development of the CRS:

Framework for CRS Development

1. **Identify Methods for Re-Establishing Chum Populations**
2. **Identify Target Populations**
3. **Identify Habitat Suitable for Chum**
4. **Identify and Obtain Brood Source for Use in Reintroduction**
5. **Identify Facilities for use in Conservation Hatchery Program**
6. **Identify Production Goals and Program Duration**
7. **Identify Artificial Production Techniques**
8. **Identify Release Strategies for Reintroduction Program**

Recommendations: Based upon our initial technical review and evaluation, we recommend that initial efforts for recovery into coast stratum populations in the ESU occur within the Clatskanie and Scappoose population areas. This is consistent with recommendations from the HSRG who indicated that ODFW should implement a conservation program in these areas using locally available chum broodstock or other suitable donor populations. These populations each contain a considerable amount of HIP spawning habitat (see Framework Element 3 below) and our evaluation indicates that critical risks such as predation by hatchery fish and harvest in lower river commercial fisheries could be smaller relative to other areas.

Appendix 5. General approach and conceptual framework to develop the experimental design for Objective 2 (stock status review) and Objective 4, (population monitoring).

As stated in our proposal, the experimental design for Objectives 2 (stock status review) and Objective 4 (population monitoring) will be developed in detail during the first year of the project. However, we will describe the general approach and conceptual framework that WDFW will use to accomplish these tasks.

WDFW agrees that a thorough stock status assessment should precede development of prescriptive plans for population recovery. We have proposed that this assessment should include an updated genetic analysis, coupled with a review of historic and recent population abundance data to provide the most current information on LCR chum population structure. Results will guide selection of priority habitat restoration projects and development of a reintroduction/supplementation plan that identifies priority populations for recovery, and potential donor stocks for reintroduction/supplementation. We also believe a comprehensive population monitoring and evaluation (M&E) plan (includes status and trend monitoring for ESA recovery, and effectiveness monitoring for evaluation of habitat restoration projects and supplementation actions) is needed prior to **implementation** of prescriptive rehabilitation plans; however, we believe development of the M&E plan can occur concurrently to prescriptive plans as long as elements of each are well integrated. Figure 1 (Page 12 of this document) provides a schematic description of the sequencing of Year 1 activities that lead to the development of an Integrated Strategy for Chum salmon enhancement in the lower Columbia River. Our response to ISRP Request #4 (Figure 7) details a timeline for completion of these activities.

"Experimental Design" for Objectives 2 and 4
In the ISRP comments by Proposal Section for Objectives 2 and 4, and reiterated here in ISRP Request #3, additional information on experimental design is requested, and it is suggested that we "work with a specialist to develop a statistically valid design for population estimation (Objectives 2 and 4)".

Objective 4 - For objective 4 (M&E plan development), it is our intent to develop a statistically valid "experimental design", in the first year of the project. We believe it is premature to develop a final M&E program design prior to completion of the stock status assessment and existing supplementation program review, also proposed for Year 1 of the project, and we propose to develop the M&E plan concurrently to these reviews, integrating key results. In addition, Chapter 7 of the LCFRB (2004) Recovery Plan describes monitoring and evaluation needs for plan implementation and provides a framework for M&E plan development; however, it does not provide the level of detail needed for the chum enhancement integrated strategy and Adaptive Management –M&E Plan:

> *"This plan provides the framework for a systematic regional approach. It generally identifies what needs to be done and how to do it. It does not drill down into specific implementation details such as desired confidence levels, statistical power, data*

> *collection protocols, sample sizes, etc. These* ***details will depend on additional refinements to the monitoring, research, and evaluation elements of this plan that will be developed as implementation planning proceeds****. Refinements will be predicated on the availability of resources for conducting an integrated monitoring, research, and evaluation program."*

Our M&E plan will be within the framework of an Adaptive Management conceptual plan consistent with the guidance provided by NOAA Fisheries Service for monitoring recovery of listed stocks (also refer to our response to ISRP Request #6). NOAA Fisheries has provided four documents detailing the need for various kinds of information for determining the status of anadromous salmonids listed under ESA:

- **Viable salmonid populations:** McElhany et al. (2000). NOAA Technical Memorandum NOAA Fisheries-NWFSC-42.
- **Habitat Restoration Monitoring:** NOAA Fisheries Service (2006)."Performance Goals, Measures, and Reporting Framework" (given to the states and tribes through the Pacific Coastal Salmon Recovery Fund).
- **Adaptive Management Framework for Monitoring:** NOAA Fisheries Service (2007) "Adaptive Management for ESA Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance"
- **Monitoring Recovery:** Crawford and Rumsey (2009). Guidance For Monitoring Recovery of Salmon and Steelhead Listed Under the Federal Endangered Species Act (Idaho, Oregon, and Washington). Draft – April 27, 2009. NOAA Fisheries Service – Northwest Region. 125 pages.

The Crawford and Rumsey (2009) document provides recommendations for monitoring VSP status and trends (see Appendix 3 for more details):

1. VSP Adult Spawner Abundance:

- Incorporate a robust unbiased adult spawner abundance sampling design that has known precision and accuracy.
- Monitor ratio of marked hatchery salmon and steelhead with an external adipose clip to unmarked natural origin fish in all adult spawner surveys.
- As a first step to improved data quality, calculate the average coefficient of variation for all adult natural origin spawner databases for ESA populations and provide that information to all interested parties.
- Collect adult spawner data with a coefficient of variation (CV) on average of 15% or less for all ESA populations.
- Conduct a power analysis for each natural population monitored within an ESU to determine the power of the data to detect a significant change in abundance.
- Utilize the protocols published in the American Fisheries Society Salmonid Field Protocols Handbook whenever possible in order to standardize methodologies across the region in evaluating population abundance.

2. VSP Productivity

- Develop at least 12 brood years of accurate spawner information as derived from cohort analysis in order to use the geometric mean of recruits per spawner to develop strong productivity estimates.
- Obtain estimates of juvenile migrants for at least one significant population for each major population group (MPG) within an ESU or distinct population segment (DPS).
- The goal for all populations monitored for juvenile migrant is to have salmon data with a CV on average of 15% or less and steelhead data with a CV on average of 30% or less.
- A power analysis for each juvenile migrant population being monitored within an ESU should be conducted to determine the power of the data to detect a significant change in abundance.

3. VSP Spatial Distribution

- Determine spatial distribution of listed species with the ability to detect a change in distribution of ± 15% with 80% certainty.

4. VSP Species Diversity

- As a short term strategy, utilize species distribution information and spawn timing, age distribution, fecundity, and sex ratios to determine status/trend in species diversity of natural populations.
- As a long term strategy, develop a baseline of DNA microsatellite markers based on single nucleotide polymorphism (SNPs), allozyme and DNA genotypes and phenotypes for each population within each MPG and ESU.

Figure 1 of the NOAA Fisheries Service (2007) Adaptive Management Framework and Monitoring Guidance document (our Figure 1 below) provides an illustration of how the VSP parameters and metrics (listed above) are incorporated into an Adaptive Management listing status decision framework.

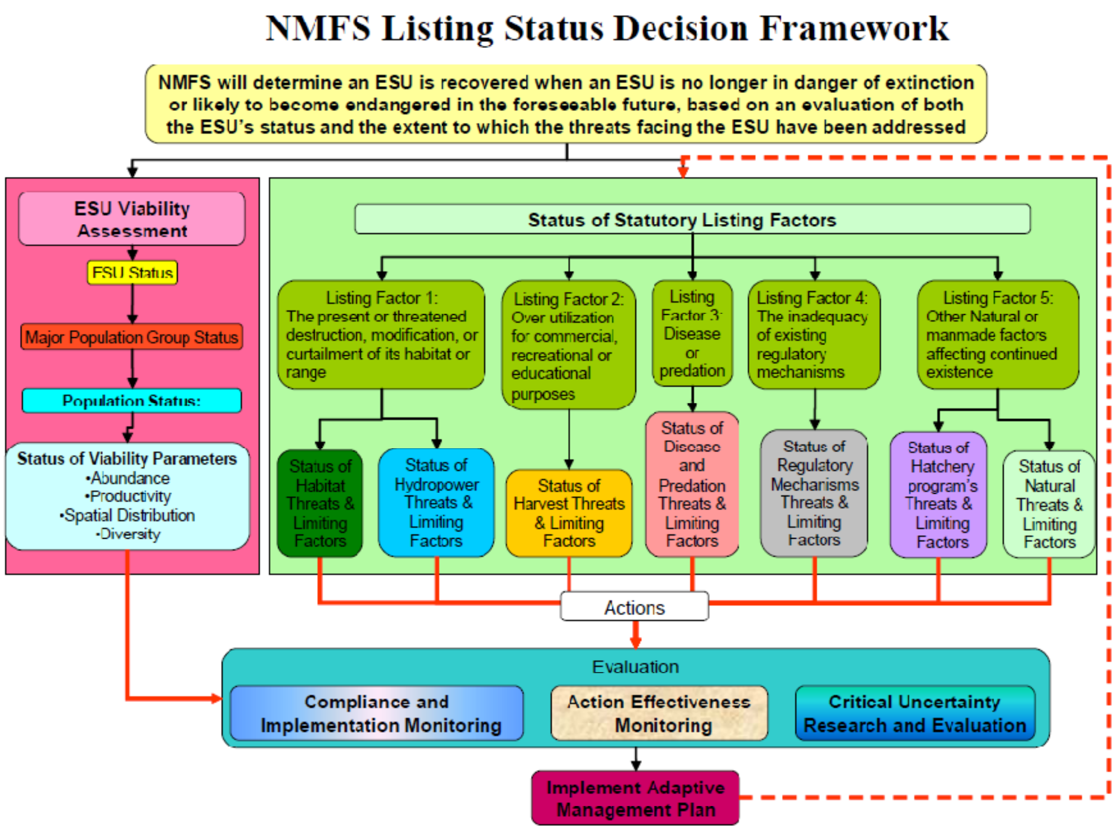


Figure 1. Illustration of the framework that links the M&E feedback from an Adaptive management plan the VSP parameters needed to evaluate the progress towards recovery relative specific causes for decline (source Figure 1 of NMFS 2007).

This Adaptive Management framework links enhancement actions and subsequent M&E – through an Adaptive Management feedback loop – to an ESU viability assessment of the VSP parameters and a review of the status of listing factors/causes for decline.

As state in our proposal, "*we propose to develop a comprehensive M&E program for LCR chum salmon populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/ reintroduction programs and habitat restoration actions.*" WDFW Science Division staff slated to assist in development of this plan are: Dr. Steven Schroder - leader of the Ecological Investigations Unit in the Science Division; Mr. Dan Rawding -lead agency scientist for salmon and steelhead population monitoring and salmon recovery in the lower Columbia River; Dr. Chris Ryding – biometrician, and Dr. Maureen Small – geneticist, WDFW Molecular Genetics Laboratory.[22]

As a Year 1 deliverable, we proposed to submit a draft of our comprehensive M&E-Adaptive Management Plan for the chum enhancement project – to BPA and the ISRP for review prior to implementation.

[22] Resumes for key WDFW Science Division personnel were included in our original proposal.

Objective 2 – The Lower Columbia/Willamette Technical Recovery Team (TRT) and the LCFRB (2004) Recovery Plan have outlined the historic population structure for LCR chum salmon and have assigned a recovery designation to each (refer to Table 4 of original proposal narrative).

The proposed LCR chum salmon stock status assessment to be completed in Year 1 is intended to answer three main questions:

1. What is the current genetic structure of chum salmon within these population designations? Which populations remain genetically unique, and functioning?
2. What is the current abundance of these populations?
3. How are existing supplementation programs contributing to the natural spawning population, both in-basin and out-of-basin (strays)?

The following components are proposed:

1. Processing of genetic tissue and otolith samples collected in 2003-08 (refer to Table 3 of original proposal narrative).
    4. Genetic tissue samples will be processed by the WDFW Molecular Genetics Laboratory following established protocols (Small et al, 1998).
    5. Otoliths will be processed and decoded by the WDFW Otolith Laboratory following established protocols (Volk et al 1999 and Brenkman et al 2007).

2. An updated analysis of LCR chum salmon population (genetic) structure.
    - Dr. Maureen Small (Geneticist, WDFW Molecular Genetics Laboratory) will perform an updated analysis of her previous work relating to LCR chum salmon genetic structure (Small et al, 2004 and 2006), using the newly acquired tissue samples described above.
    - Objectives are:
        i. identify and characterize genetic linkages between existing populations of LCR and other nearby (Oregon coast and Willapa Bay) chum salmon populations.
        ii. identify, based on genetic analysis, which existing populations could be used as broodstock for supplementation/reintroduction into streams where chum salmon have been or are nearly extirpated (potential donor stocks).
        iii. and identify which populations are genetically unique and functioning – for these, native broodstock is preferred for supplementation.

3. A review and update of historic and recent chum salmon abundance data.
    - Historic chum salmon abundance data is stored in a variety of forms: raw data (i.e. stream survey counts of live & dead fish, and redds), estimates of fish per mile, peak index counts, estimates of abundance from peak count expansion.
    - More recent abundance data has been generated using more robust estimation methodologies, primarily: Area-Under-the-Curve (AUC) and Jolly Seber Mark/Recapture [A detailed description of methodologies can be found in Rawding and Hillson (2003) and Rawding et al. (2006).]

- Mr. Dan Rawding (lead agency scientist for salmon and steelhead population monitoring and salmon recovery in the Lower Columbia River) and Dr. Chris Ryding (biometrician) of the WDFW Science Division Stock Assessment Unit will assist with this review.
- Objectives are:
    i. Estimate annual chum salmon abundance with confidence intervals for LCR chum salmon (1940's to the present) in a standardized analytical framework.
    ii. Develop annual estimates of stock origin, age composition, and sex ratios for LCR chum salmon populations.
    iii. Report on chum salmon status relative to VSP and recovery plan goals.
    iv. Storage of raw and summarized population data (WDFW SaSI, STREAMNET)
    v. Highlight key assumptions for escapements (Strengths & Weaknesses Assessment)
    vi. Develop sampling & analysis manuals, and tools for future escapement estimation.
    vii. Integrate results with M&E program development to meet WDFW, LCFRB, NOAA, and BPA Fish & Wildlife Program goals.

4. A review of existing supplementation programs (i.e. Grays River and Duncan Creek) –
    - Chum salmon produced from each brood year of these supplementation programs have all been given a unique batch mark via thermal or strontium marking of the otolith.
    - Otolith processing and decoding described above provides a means to determine the contribution of supplementation programs to natural spawning populations.
    - To date, only a cursory examination of contribution rates has been done. A full examination would include temporal and spatial distribution, contribution by brood year & gender and estimates of fry-to-adult (ocean) survival rates.
    - Dr. Steven Schroder (leader of the Ecological Investigations Unit) in the WDFW Science Division will assist with this review.

5. Review of and coordination with habitat restoration and supplementation recovery strategies presented in relevant documents and processes, including:
    - in the LCFRB's Recovery Plan (2004),
    - NOAA Fisheries (2006, 2007, 2008, 2009) guidance documents,
    - NOAA Fisheries (2008) FCRPS Biological Opinion – Comprehensive Analysis and RPAs; and
    - Coordination with other relevant salmon recovery and management entities –
        i. ODFW chum recovery planning and processes,
        ii. LCFRB habitat restoration planning and activities,
        iii. LCREP habitat restoration planning and activities,
        iv. WDFW-BPA-Corps Estuary MOA implementation, and
        v. The expert panel for evaluation of the benefits of estuary habitat restoration projects established under RPA 35.

Appendix 6. Adaptive Management Framework for LCR Chum Restoration (Project 2008-710-00)

Definitions of "Adaptive Management"

The functional definition of the "Adaptive Management" concept varies according to the application and the complexity of the relevant Hatchery, Harvest, Hydro or Habitat management action under consideration. For example, adaptive management of a specific tributary fishery may involve tools such as creel surveys and time-area-gear restrictions to make in-season adjustments in order to achieve a limitation on take of a listed species; whereas adaptive management of Washington PFMC ocean and inside fisheries has evolved into a complex "North of Falcon" process that incorporates biological, economic, institutional, social, cultural, and inter-national considerations within a well-defined Federal-State-Tribal organizational structure.

Similarly, adaptive management of planning processes such as the Council's Fish & Wildlife Program, Subbasin Plans for a watershed or region, a NMFS-approved ESA Species Recovery Plan, or a specific enhancement project that implements a component of a recovery plan – would all vary in complexity. However in the latter example, it has been recognized by the Columbia Basin Fish & Wildlife scientific community and agency administrators – that a common or compatible framework is needed for Basin-wide programs, ESU-level plans or focused enhancement projects.

NPCC (1984) simply defined Adaptive Management as – *learning by doing*. Others have proposed to incorporate the scientific method into Adaptive Management by designing a large-scale field experiment (e.g., a habitat enhancement project) to test specific hypotheses.

According to the LCFRB (2004), the term "adaptive management" is in wide usage among subbasin planners and has come to denote two very different processes (see Appendix 1.2.1 for more details):

- *"A broad definition involves course correction during plan implementation based on observed progress and refinements in approach or objectives.*
- *An alternative definition involves a specific approach whereby substantive actions are implemented in order to invoke a significant response that provides clear direction for tuning*."

The following definition is relevant to ESA Recovery Plans (NMFS 2007):

> *"Adaptive management is the process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative*

> *strategies to achieve the same ends are proposed, prioritized, and implemented when necessary."*

Adaptive Management Framework

In the Chum Enhancement Project proposal, WDFW uses the term Adaptive Management within the ESA Recovery Framework detailed by NMFS (2007) ; refer to Appendix 1.2.2 for more detail. The NMFS (2007) guidance document provides relevant information in the following sections:

- Section 3 provides a conceptual overview of adaptive management.
- Section 4 describes guiding principles for the development of two types of monitoring: *status and trends monitoring* and *effectiveness monitoring*.
- Section 5 discusses, at a conceptual level, the issues related to prioritizing monitoring in the face of resource constraints.
- Section 6 illustrates how monitoring program design can affect the level of certainty that can be attained in evaluating ESU status.

Excerpt on Adaptive Management (NMFS 2007):

Adaptive management is the process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation, and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends are proposed, prioritized, and implemented when necessary.

An adaptive management plan must include the following elements (Anderson 2003):

- Management strategies that are revisited regularly;
- The use of conceptual or quantitative models of the system being managed to develop and test hypotheses and to guide strategy and action planning;
- A range of potential management actions that could be used to meet the strategy;
- Monitoring and evaluation to track progress;
- Mechanisms for incorporating learning from monitoring and evaluation into decisions on actions and strategies; and
- A collaborative structure for stakeholder participation in adjusting management strategies and actions.

Adaptive management is crucial for salmonid recovery programs because of the length and complexity of the salmonid life cycle and the uncertainties involved in improving salmonid survival and status. The key is to build explicit links between management actions, monitoring data, and biological and physical responses. Several types of monitoring are needed to support adaptive management:

- Implementation and compliance monitoring, used to evaluate whether the recovery plan is being implemented.
- Status and trend monitoring, which assesses changes in the status of an ESU and its component populations, and changes in status or significance of the threats to the ESU.
- Effectiveness monitoring, which tests hypotheses on cause-and-effect relationships and determines (via research) if an action is effective and should be continued.

It is also important to explicitly address the many unknowns in salmon recovery – the "critical uncertainties" that make management decisions much harder. Critical uncertainty research may seem expensive or unnecessary in light of basic information needs; however, in the long run, it will reduce monitoring and implementation costs.

As local recovery planners begin to design monitoring programs for salmon recovery, they will need to address the issues that are discussed conceptually throughout this document, including:

1) Clarifying the questions that need to be answered for management decision making.
2) Identifying which populations and associated limiting factors to monitor.
3) Addressing questions of metrics and indicators – frequency, distribution, and intensity of monitoring – and the tradeoffs and consequences of these choices.
4) Assessing the degree to which existing monitoring programs are consistent with this guidance document and identifying needed adjustments in those programs as well as additional monitoring needs and a strategy for filling them.
5) Developing a data management plan (see Appendix B of NMFS 2009).
6) Prioritizing research needs to address critical uncertainties, test assumptions, and provide other information to support decision making.

How the Scientific Method and Hypothesis Testing Fit into Adaptive Management, Monitoring and Evaluation

The LCFRB (2004) Salmon Recovery Plan made the following observation on testing hypotheses on the salmon enhancement project level:

> *"Working hypotheses provide a sound basis for identifying and scaling a suite of appropriate recovery actions but substantial refinements in the scope and focus of measures will be needed as the recovery effort unfolds. Some measures may not produce the desired effects. Other measures will exceed expectations. Unexpected events will occur. A robust and adaptive monitoring, research, and evaluation framework will be critical for weighing progress toward recovery and making appropriate course adjustments along the way."*

The Chum Enhancement Project could be viewed as a grand adaptive management experiment with overarching hypotheses to be tested; however, that would accomplish little more than a restatement of the purpose and goals of the project. Examples of such hypotheses would be:

- Supplementation of artificially propagated chum fed-fry – derived from natural-origin parents – into functioning rearing habitats currently not inhabited by chum salmon will (will not) produce a viable self-sustaining chum population over a 15-year time period.
- Restoration of degraded habitat that previously supported a viable chum salmon population but is now devoid of chum, combined with supplementation of artificially propagated chum fed-fry into this rehabilitated habitat will (will not) produce a viable self-sustaining chum population over a 15-year time period.
- Supplementation of natural-origin adult chum spawners into a engineered chum spawning channel adjacent to functioning rearing habitats currently not inhabited by chum salmon will (will not) produce a viable self-sustaining chum population over a 15-year time period.

We prefer to utilize the NMFS (2007) framework that incorporates status and trend monitoring to evaluate the efficacy on the chum supplementation management actions at each site. Status and trend monitoring – with statistically valid methodology will determine if a supplemented chum population – in a functioning or rehabilitated habitat – is increasing or decreasing in abundance. It cannot alone determine if there is a cause-effect relationship between supplementation and population change. Likewise, monitoring of an adult spawning population can determine if the numbers (proportions) of supplementation-origin versus natural-origin chum salmon changes over time.

Two aspects of the Adaptive Management-M&E Plan will incorporate hypothesis testing:

2) The effectiveness monitoring of habitat restoration actions, and
3) critical uncertainties research to gain knowledge of key biological relationships comprising the scientific foundation for the supplementation program.

NMFS (2007) states the importance of incorporating effectiveness monitoring into the Adaptive Management – M&E Plan:

> *While status and trends monitoring can produce data on population status and on the status of the potentially limiting factors, without some modeling (quantitative, qualitative, heuristic), supported by effectiveness monitoring data, it is impossible to translate between these two data sets or types, i.e. to make cause-and-effect statements. It is essential to build effectiveness monitoring into the implementation plan at the outset, because it requires explicitly coupling the monitoring design and implementation with the action design and implementation in order to detect an effect. Recovery plan implementation should consist of action strategies that include the demonstration of effect.*

NMFS (2007) also describes the role of critical uncertainties in recovery planning – the current suite of unanswered questions – can also drive monitoring:

> *There is real and necessary value to data collection programs that address the critical uncertainties confounding our ability to make effective management*

> *decisions. This research-based monitoring is also driven by management questions, in a less direct, but equally important, manner.*

This NMFS guidance document presents some basic design principles to help develop efficient and effective monitoring programs.

Appendix 7. WDFW's provisional criteria and methodology for evaluating the efficacy of habitat restoration projects and potential production from chum spawning channels.

In this proposal we provide the following provisional list of criteria and metrics – largely modeled after those used by LCFRB (2004, 2009) to rank habitat projects:

- Population recovery designation for affected chum salmon population - "primary" or "core" designations (LCFRB and Lower Columbia/Willamette TRT, respectively; (Table 2 of original proposal) should be given priority.
- Quantity/quality of restored habitat provided.
- Life history stage(s) benefitted.
  - Is creation of spawning habitat part of the project?
  - What level of spawner abundance will be supported?
- Documentation of current or historic spawning in the location.
  - Is or was the location used by chum salmon?
- Feasibility/Risk Assessment.
  - How likely is it that the project will be successful?
  - How stable is the location?
  - Build on LCFRB work group and other assessments where available.
- Cost – if estimates are available.
  - Utilize LCFRB and other project lists where available.

We also state in the proposal that "*The criteria/metrics that will be used for ranking habitat restoration and chum channel locations will be finalized prior to assessment…*"

Appendix 8 of this proposal describes the criteria that will be used by the Lower Columbia Fish Recovery Board (LCFRB 2009) Technical Advisory Committee (TAC) and staff to evaluate habitat protection and restoration project proposals.

In our original proposal, we state:

> "*The intent of this proposal is not to conduct or re-evaluate habitat assessments already completed or compiled through the LCFRB or other processes, but instead to utilize the LCFRB Recovery Plan, existing stream habitat assessments and restoration project lists to develop a prioritized list of habitat restoration projects and/or locations within the LCR that would be the most beneficial to chum salmon.*"

The proposal section entitled: "*Provisions of the NOAA Fisheries 2008 FCRPS BiOp and the WDFW-Federal Estuary MOA add $90 Million in new Habitat Restoration Work Below Bonneville Dam*" provides relevant information. Prioritization of these major ongoing and new BPA-funded habitat restoration efforts will be scoped and prioritized by criteria previously documented by LCFRB, LCREP, and the NOAA Fisheries Estuary Recovery Module (NOAA Fisheries 2007), including the "Draft: Estimated Benefits of Federal Agency Habitat Projects in the Lower Columbia River and Estuary" (FCRPS-BA Attachment B.2.2-3; PC Trask & Associates 2007). In addition, an expert panel will be formed to assist in ranking habitat restoration projects in the LCR and estuary as specified in RPA 35 of the NOAA Fisheries 2008 BiOp (see Appendix 9 of this proposal). Project 2008-710-00 will be coordinating closely with all these habitat restoration ranking processes.

The NOAA Fisheries Habitat workgroup (NOAA Fisheries 2007) has developed guidelines and preliminary methodology for estimating biological benefits of habitat restoration projects. A brief summary relevant to chum salmon is presented in the following section.

Estimating Biological Benefits of Habitat Restoration (NOAA Fisheries 2007)

Salo (1991) summarized egg-fry survival rates of chum salmon in his Tables 10 and 11. His summary indicates that egg-fry survivals of naturally produced chum salmon in natural environments can range from 0.1 to 85.9%. The latter is an estimate of survival of chum in the Iski River (tributary to the Amur River in Russia). Since most chum survival estimates in other systems are less than 35%, the Iski River (85.9%) estimate appears to be an outlier. Quinn's (2005) review indicated a mean egg-fry survival of 12.9% for chum salmon.

The following egg-smolt and egg-fry survival estimates appear reasonable if one assumes optimal (100% habitat quality) spawning and rearing conditions (NOAA Fisheries 2007):

- Chinook Salmon: 18% egg-smolt survival
- Steelhead: 4% egg-smolt survival
- Chum Salmon: 35% egg-fry survival

These estimates represent the highest survivals that could be achieved under optimal habitat conditions. The NOAA Fisheries Habitat workgroup also assumed that the maximum pre-spawning adult survival would be 100% at optimal conditions.

Applying these maximum survival rates to optimal habitat conditions resulted in linear functions with different slopes (rates of change) for each species and life stage; refer to Figure 7.1 for the chum egg to fry survival function and Figure 7.2 for pre-spawning adult survival. The NOAA Fisheries Habitat Workgroup used the following linear functions to guide professional judgment in estimating survival improvements associated with habitat quality improvements:

- Chinook salmon egg-smolt survival = 0.0018*(Habitat Quality)
- Steelhead egg-smolt survival = 0.0004*(Habitat Quality)
- Chum salmon egg-fry survival = 0.0035*(Habitat Quality)

- Adult pre-spawning survival = 1.0*(Habitat Quality)

These functions provided a conservative approach to estimating survival gains and resulted in estimates that were generally less than those calculated with the Ecosystem Diagnosis and Treatment (EDT) model.

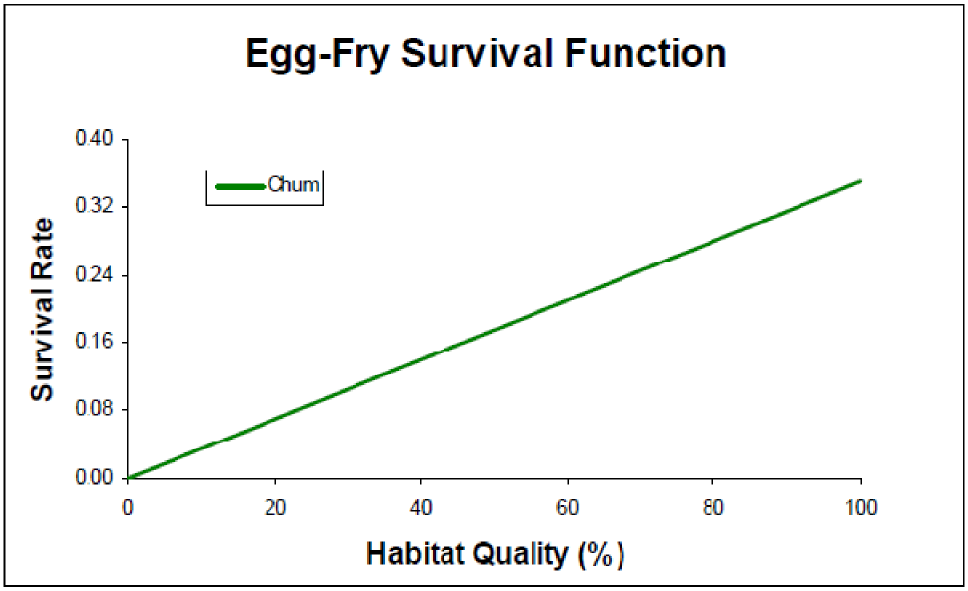


Figure 7.1. Linear functions for egg-fry survival of chum salmon (NOAA Fisheries RM&E 2007).

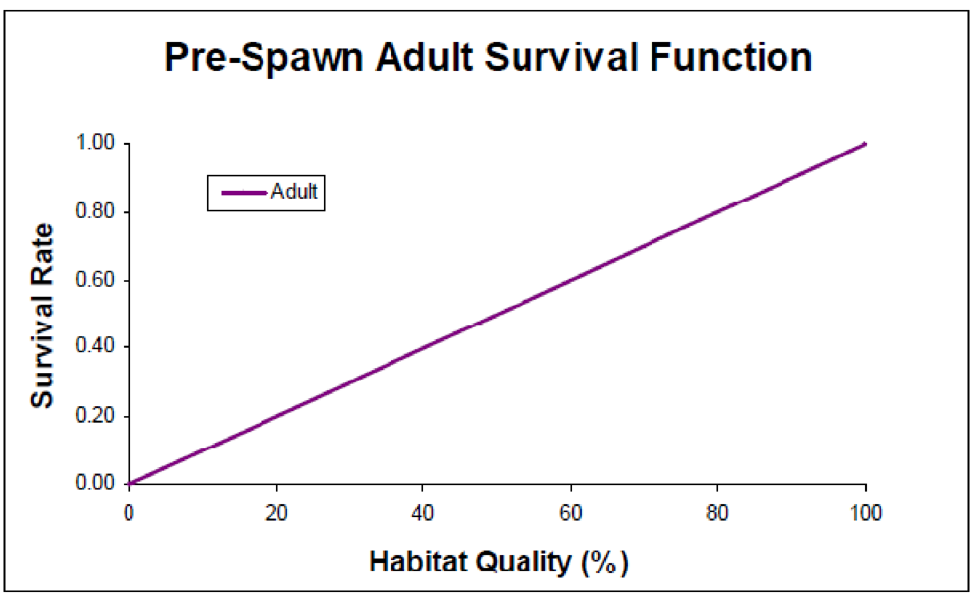


Figure 7.2. Linear functions for pre-spawning adult survival of chum salmon (NOAA Fisheries RM&E 2007).

Estimate of Potential Biological Benefits of a Proposed Habitat Restoration Project – Chum Spawning Channel to Enhance the Existing I-205 Chum Salmon Population

The following section is an excerpt from Vigg (2009) that illustrates a methodology to estimate the potential biological benefits of a site-specific chum channel. This approach incorporates an egg-to-fry survival function (as in Figure 7.1, but adjusted to extant data on chum survival functions in spawning channels); and also models the range of potential fry production according to assumptions regarding the following physical and biological parameters:

- Useable length, width and area of the spawning channel;
- Proportion of channel with suitable spawning substrate;
- Fecundity (eggs per female); and
- Sex ratio of spawning population.

The potential chum salmon biological benefits were estimated -- based on the spawning channel characteristics described in the Lower Columbia Fisheries Enhancement Group (LCFEG) conceptual design report (Otak, Inc. 2007) and Columbia River chum salmon biological characteristics (Todd Hillson, Personal correspondence, April 13, 2009). Based on the estimated chum salmon spawning population that could use the spawning channel, the potential chum salmon fry production was projected (Table 7.1). The total spawning population size supported by this spawning channel would be about 263 females or 526 total spawning adults (range 468-586 spawners) assuming a sex ratio of 1:1 males to female.

The total annual chum production was estimated to be about 340,000 fry (range of 271,547 to 408,240). This estimate is based on the following assumptions:

- The minimum channel bottom area is 8,400 sq-ft – based on a channel that is 6 ft wide and 1400 feet in length;
- Spawning area per female for optimum spawning density is 21.53 to 26.91 square feet (i.e., 2 to 2.5 square meters);
- Assuming that 50% to 75% of the spawning channel would be suitable spawning substrate and therefore utilized for redds – I estimated that 234-293 redds would be produced.
- Given an average fecundity of 3,000 eggs per female (2,900 to 3,100) about 793,068 eggs would be deposited in the redds (range of 678,936 to 907,199); and
- An egg-to-fry survival of 40- 45 percent would result in the estimate of 271,547 to 408,240 chum fry produced per year.

Table 7.1. Calculations of potential chum fry production derived from the proposed chum spawning channel at Columbia Springs or Woods Landing sties. (Source of Columbia River chum salmon biological characteristics -- Todd Hillson, Personal correspondence, April 13, 2009).

CHUM SALMON SPAWNING ESTIMATE:	VALUE	
	Range	Mid-Point
Estimated length of spawning channel (ft):	--	1,400
Minimum Channel Bottom Area (sq-ft):	--	8,400
Assume Percent of Channel -- Useable (upper %):	75.0%	62.5%
Assume Percent of Channel -- Useable (lower %):	50.0%	
Area of Channel -- Useable (upper sq-ft):	6,300	5,250
Area of Channel -- Useable (lower sq-ft):	4,200	
Females per available area (upper range):	293	263
Females per available area (lower range):	234	
Eggs per Female (upper range):	3,100	3,000
Eggs per Female (lower range):	2,900	
Total Egg Produced (upper range):	907,199	793,068
Total Egg Produced (lower range):	678,936	
Egg-to-Fry Survival (upper-percent):	45.0%	42.5%
Egg-to-Fry Survival (lower-percent):	40.0%	
Total Fry Produced (upper range):	408,240	339,907
Total Fry Produced (upper range):	271,574	

Appendix 8. Lower Columbia Fish Recovery Board 2009 Habitat Project Application Evaluation Criteria and Questions. (LCFRB Web Site: http://www.lcfrb.gen.wa.us/2008%20HWS.htm)

Appendix 8.1. Lower Columbia Fish Recovery Board (2009) Habitat Project application Evaluation Questions.

I. OVERVIEW

This document describes the criteria that will be used by the Lower Columbia Fish Recovery Board (LCFRB) Technical Advisory Committee (TAC) and staff to evaluate habitat protection and restoration project proposals.

Proposals are evaluated to determine their potential benefits to fish and the likelihood or certainty that they will achieve those benefits.

Benefits to Fish can be generally defined as improvements in productivity, abundance, and/or distribution of a fish population. They are determined based on measures, strategies, actions, and priorities identified in the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB, 2004) and the 6-Year Habitat Work Schedule (LCFRB 2008). The two key components of the Benefits determination are:

a. The importance of the fish populations, key life history stages and associated limiting factors targeted by the project; and
b. The extent to which the project will address the targeted limiting factors. Of equal importance to a project's potential benefits is the likelihood that it will achieve those benefits. Key considerations in evaluating a project's Certainty of Success are:

a. Whether the project scope and approach are technically appropriate;
b. The extent to which the project is coordinated with other habitat protection and restoration efforts in a watershed;
c. Physical (site or watershed conditions), legal, social, or cultural constraints;
d. The qualifications and experience of the sponsor;
e. Community and landowner support; and
f. Adequacy of stewardship and maintenance provisions.

Using this evaluation process, each project is assigned Benefit and Certainty ratings of High, Medium, or Low as well as a numerical score. Each project is then assigned to priority grouping 1 through 4 based on its benefit and certainty ratings using the matrix (Table 1). Finally, projects are ranked within each priority group based on their numerical scores.

Table 1. Project Priority Grouping Matrix

		Certainty		
		High	Medium	Low
Benefit	High	Group 1	Group 2	Group 4
	Medium	Group 2	Group 3	Group 4
	Low	Group 4	Group 4	Group 4

A more detailed discussion of Benefit and Certainty ratings and scoring is provided below.

II. BENEFITS TO FISH
a. Introduction
Benefit to fish ratings and scores are the combination of:

1. A population/reach rating and score;
2. The Protection/Access/Restoration (PAR) Ratings and Scores; and
3. Cost Score

Benefit Ratings are High, Medium, and Low and the maximum Benefit Score is 200 points. It should be noted that in developing a benefit score and rating it is assumed that each proposed project will achieve its goals and predicted outcomes. The likelihood that a project will actually achieve its goals or predicted outcomes is evaluated in determination of the project's Certainty of Success.

In evaluating a project's potential benefit to fish, LCFRB Staff and the TAC will rely heavily on the technical information and the strategies, measures, actions, and priorities contained or referenced in the Recovery Plan and the 6-Year Habitat Work Schedule. Applicants may take exception to this information in their project proposals and provide technical information supporting such an exception. The LCFRB staff and the TAC will consider the technical information or justification provided by the sponsor in evaluating the proposal.

b. Population/Reach Ratings and Score
1. Introduction.
Population/Reach Ratings and Scores reflect the degree to which a project targets priority populations and reaches Identified in the Recovery Plan and 6-Year Habitat Work Schedule.

The Population/Reach Rating uses reach Tier designations set forth in the recovery plan to indicate whether a project is targeting a high priority population(s) and a high priority reach for the population(s). Reach ratings are High, Medium, and Low. The Population/Reach Score is used to further differentiate between projects with the same Population/Reach Rating.

The Population Reach Score is based on the number of populations within the reach or reaches targeted by the project, the population recovery goals, and the importance of the targeted reach or reaches to the productivity and abundance of the populations. The maximum Population/Reach Score is 100 points.

2. Population/Reach Rating
A project's Population/Reach Rating is based on the Tier of the targeted reach or reaches. Tier ratings are based on Population Recovery Goals (Table 2) and the EDT-derived Species Reach Potential and are assigned in the Recovery Plan based on the rules in Table 3.

Table 2. Population Recovery Goals

Population Classification	Viability Goal	Description	Persistence Probability[1]
Primary (P)	High (H) or High+ (H+)	Low (negligible) risk of extinction (represents a "viable" level)	95-99%
Contributing (C)	Medium (M)	Medium risk of extinction	75-94%
Stabilizing (S)	Low (L)	Stable, but relatively high risk of extinction	40-74%

[1]100-year persistence probabilities (LCFRB 2004)

Table 3. Reach Tier Designation Rules

Designation Rule	
Reaches	**Rule**
Tier 1	All high priority reaches (based on EDT) for one or more primary populations.
Tier 2	All reaches not included in Tier 1 and which are medium priority reaches for one or more primary population and/or all high priority reaches for one or more contributing populations.
Tier 3	All reaches not included in Tiers 1 and 2 and which are medium priority reaches for contributing populations and/or high priority reaches for stabilizing populations.
Tier 4	Reaches not included in Tiers 1, 2, and 3 and which are medium priority reaches for stabilizing populations and/or low priority reaches for all populations.

If a project targets a Tier 1 reach or Tier 1 reaches, it receives a "High" rating. If it targets no Tier 1 reach or reaches, but targets one or more Tier 2 reaches, it receives a "Medium" rating. If it targets only Tier 3 or 4 reaches, it received a "Low" rating.

Projects proposed for the Lower Columbia mainstem and estuary and the tidally influenced portions of tributaries may also benefit out-of-basin or upriver populations. In such cases, out-of-basin salmon and steelhead populations are collectively considered a "Primary" population. No EDT analysis has been conducted for out-basin-populations. In absence of such analyses, targeted reaches with out-of-basin salmon and steelhead populations are considered Tier 2 and given a "Medium" rating.

3. Population/ Reach Score:
In addition to its Population/Reach Rating, each project receives a numerical Population/Reach Score. Reaches differ in their actual or potential value to fish populations. This score reflects those differing reach values within a given Tier. Specifically, reaches within the same Tier may be utilized by a varying number of populations with different recovery goals. In addition, the targeted reach or reaches may differ in importance to the populations. The score is the cumulative total of the Population Classification (Primary = 3, Contributing = 2, Stabilizing =1) plus the Species Reach Potential (High=3, Medium=2, Low=1) for each population using the targeted reach or reaches. The Population Goals (Table 3) and Species Reach Potential ratings were taken from the Recovery Plan and 6-Year Habitat Work Schedule.

As with the population reach rating, the population/reach score for projects targeting out-of-basin salmon and steelhead populations is calculated based on the out-of-basin populations being collectively considered “Primary” populations and the Species Reach Potential as “Medium.”

For multiple reach projects, Population/ Reach Score is the average of the Population/ Reach scores for the individual reaches.

c. The Protection/Access/Restoration (PAR) Ratings and Scores
1. Introduction
The Protection/Access/Restoration (PAR) rating and score reflect whether a project targets priority habitat project needs and the extent to which the project would be anticipated to address those needs. The PAR rating indicates whether a project is targeting a high priority habitat need. PAR ratings are High, Medium, and Low. A project is given an overall PAR rating of High, Medium, or Low based on the rating of the project’s predominate restoration type or, if the project is felt to address several project types to an equal or similar degree, an average of the project type ratings is used.

The PAR Score is an estimate of the extent to which a project addresses the targeted habitat need(s). Based on the project proposal and other information supplied by the sponsor, the anticipated quantity and quality of habitat protected and/or restored are assessed to arrive at the PAR score. A project’s overall PAR score is the sum of its protection, access, and restoration. Protection, access, and restoration scores are normalized so that they carry equal weight. The score range for the overall PAR score is 0 to 85 points. The initial PAR score is developed by LCFRB staff. The LCFRB TAC reviews and may revise the PAR score based on its evaluation of the project.

2. Protection Rating and Score
The protection rating is based on the EDT preservation rating for the targeted each or reaches using the flowing scale:

Table 4. Protection Rating

EDT Reach Preservation Rating	Protection Rating
>50%	High
25 to 49%	Medium
<25%	Low

Reach EDT preservation ratings are found in the Recovery Plan. The protection score is the product of the EDT preservation rating times the number of habitat units. One habitat unit equals 500 feet of stream length on both sides or 1,000 feet of stream length on one side of the stream.

3. Access Rating and Score

The access rating is based on the quality of the habitat that would be made available and a passage improvement factor. The quality is the average of upstream Tier reach ratings, where Tier 1=4 points, Tier 2=3 points, Tier 3=2 points, and Tier 4=1 points and an average Tier score of 3 or greater is “high”, 2 but less than 3 is “medium”, and less than 2 is “low”. Where no Tier rating is available the quality factor is derived using habitat assessment data provided by the project sponsor. The passage improvement factor is equal to proposed passibility percentage less the current passibility percentage furnished in the project application, where a score of 60 to 100% is “high”, 30 to 59% is “medium” and <30% is “low”. The overall access rating is then derived using the matrix in Table 5.

Table 5. Access Rating Matrix

		Habitat Quality		
Passage Improvement		High	Medium	Low
	High	High	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low

The access score is the product of the passage improvement percentage times the appropriate Habitat Quality and Habitat Quantity Factors selected from Table 6.

Table 6. Access - Habitat Quantity and Quality Factors

Habitat Quantity	Quantity Factor	Habitat Quality	Quality Factor
5+ miles	10	High	10
2 to 4.9 miles	6	Medium	6
1 to 1.9 miles	4	Low/Unknown	2
0.5 to 0.9 miles	2		
<0.5 miles	1		

4. Restoration Rating and Score
The restoration rating indicates priority or importance of the restoration needs or types addressed by a project. Except where noted below, the restoration rating is based on the EDT-derived multiple species restoration type ratings (High, Medium, Low) provided in the 6-Year Habitat Work Schedule for the reaches targeted by a project. For each reach, the ratings for the restoration types covered by the project are averaged and rounded up to the next highest rating. Based on NOAA's proposed Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead (NOAA, 2007), projects targeting estuary reaches and/or tidally influenced tributary reaches will receive a "high" restoration rating if their primary focus is:

• Restoration of degraded riparian areas; and/or Reconnection and/or restoration of floodplains, estuarine wetlands, and off-channel habitats. The overall restoration score indicates the extent to which it is estimated that a project will address its targeted restoration types or needs. The overall score is the sum of the reach restoration scores for each reach targeted by a project. The reach restoration score is sum of the scores for each restoration type proposed for the reach by the project. The score for each restoration type is the product of the restoration type rating (High=3, Medium=2, Low=1) times the number of habitat units times an effectiveness factor.

A habitat unit equals:
(1) 500 feet on both sides of the stream or 1000 feet on one side of the stream for riparian, floodplain, and hillslope process project types; or (2) 500 feet of stream length for instream and side-channel/off-channel project types. The effectiveness factor reflects a percentage estimate of the extent to which the project would address the project type within the targeted habitat unit. For example, if the project were deemed to be fully effective in creating instream habitat structure it would receive an effective factor of 100%. Initial effectiveness factors and the findings upon which they are based are developed by LCFRB staff and subsequently reviewed and revised as deemed appropriate by LCFRB Technical Advisory Committee (TAC).

The recovery plan and more recent assessments and studies identify marine- derived nutrients as an important element in supporting and maintaining stream ecosystem conditions needed by fish. However, a comprehensive survey and assessment of nutrient conditions in the Lower Columbia tributaries has not been conducted. Due largely to the lack of such survey data, the 6-Year Habitat Work Schedule does not identify reach-level Nutrient Enhancement project needs. In scoring nutrient enhancement project proposals, a project type rating of medium will be used. In evaluating effectiveness, nutrient loading levels and the duration (years) of enhancement effort will be considered.

While many habitat project proposals include both design and implementation or construction phases, Design-only proposals may be submitted for large and/or complex restoration projects. A design project can help to ensure that a subsequent implementation/ construction project is technically sound, feasible, and maximizes fish benefits. However, while a design project can substantially enhance fish benefits and certainty of success of a restoration project, it does not produce tangible on-the-ground outcomes. Accordingly, design projects will be scored using an effectiveness factor of 50 percent (0.50) for a project producing a final design and 30 percent (0.30) for a project producing a preliminary design. Final and preliminary design levels are defined in SRFB Manual 18, Appendix D.

Assessment projects focus on evaluating habitat and watershed conditions, developing restoration strategies and identifying site specific restoration and/or protection opportunities in multiple reaches, a watershed, or Subbasin. Like design projects, they do not result in tangible on-the ground benefits. While they may produce conceptual designs, they do not result in detailed designs ready for implementation. Since assessments often involve multiple reaches, an average, rather than the sum, of their restoration benefits will be used. An effectiveness factor of 10 percent will be used for all project types being addressed in an assessment. Finally, the average restoration benefit score is weighted to give a higher priority to assessment focusing on comprehensive restoration prescriptions for multiple reaches. This is done by multiplying the average restoration benefit score for an assessment covering 5 or more reaches by a factor 1.25. An assessment covering 1 or 2 reaches is multiplied by 0.75.

d. Cost Score Each project is evaluated by the TAC to determine if the cost is reasonable relative to the likely benefits. This evaluation is based on professional judgment taking into consideration labor, material and administrative costs in comparison to past projects. The scoring range is 0 to 15 points.

Final Benefit Ratings and Scores

A project's overall benefit rating is a combination of the Population/Reach and PAR ratings and is determined using the following matrix. The overall benefit rating is combined with its certainty rating (described below) using the Table 1 matrix to establish a project's priority grouping.

Table 7. Overall Benefit Rating Matrix

		Protection/Access/Restoration Rating		
		High	Medium	Low
Population/Reach Rating	High	High	Medium	Low
	Medium	Medium	Medium	Low
	Low	Low	Low	Low

A project's overall benefit score is the sum of its Population/Reach Score, its PAR score and its Cost score. The maximum possible score is 200 points. The benefit score is combined with a project's certainty score and used to rank a project within its project priority group.

III. CERTAINTY OF SUCCESS

a. Introduction

The second project proposal evaluation category is Certainty of Success. While the Benefits to Fish category looks at how well a project targets important populations, reaches, and limiting factors and evaluates the potential benefits to fish, the Certainty category evaluates how likely a project is to achieve proposed outcomes or benefits. The Certainty of Success is given equal weight to Benefits in evaluating a project. The overall scoring range for Certainty of Success is 0 to 200 points. Additional detail on the factors considered by the TAC in scoring these categories can also be found in Attachment 1 (2009)

Habitat Project Application Evaluation Questions).

b. Scoring Categories

Rating	Score Range (0 to 15)
High	11 to 15
Medium	6 to 10
Low	0 to 5

Projects should have a well-defined work scope that is tied directly to its stated goals and objectives. Clear connections between a project's work scope and its goals and objectives help assure that project sponsors have clearly identified how they will reach their stated goals and objectives.

The proper work scope and success of a project requires a solid understanding of conditions and watershed processes that cause or contribute to the problem or limiting factor being addressed. Projects with a scope and design that account for the causes of limiting conditions and processes will be given priority. For some projects, EDT, IWA, and existing LFA information may be sufficient. More complex problems may require a more thorough assessment of conditions and watershed processes. This information may be available through existing studies and evaluations. In some cases, additional site- specific assessments and design work may be needed.

2. Approach

Rating	Score Range (0 to 75)
High	51 to 75
Medium	26 to 50
Low	0 to 25

The certainty of a project's success can be enhanced through the use of proven and accepted methods and technologies. Projects should utilize approaches and technologies that are commensurate with the project's biological and habitat objectives and the nature, scope, and complexity of the problem being addressed. In selecting technologies to be employed in addressing a habitat attribute, sponsors should ensure that larger-scale watershed processes and conditions that can affect the project site have been identified and taken into account. Additionally, sponsors should clearly identify any potential impacts a project may have on upstream, downstream, and/or adjacent habitat.

Innovative or experimental approaches may be acceptable if no proven method exists or it can be shown that they will extend knowledge of restoration methodologies at a reasonable risk. In order to assess whether a project has an adequate supporting technical basis, it will be important that the project proposal addresses considerations listed for its project type contained in the Guidance on Watershed Assessment for Salmon, Part Three (Joint Natural Resources Cabinet, State of Washington, May 2001)

(Appendix XI). LCFRB technical staff and the WDFW Watershed Steward will help project sponsors identify existing documents that provide technical support for proposed projects.

For acquisition projects, the sponsor must establish why acquisition is the most appropriate method for achieving the project's goals. If fee title acquisition is proposed, the sponsor must explain why a less-than-fee approach, such as a conservation easement, would not achieve the project's goals. Finally, for any acquisition the sponsor must obtain the concurrence of the affected city or county.

Assessments, designs, and feasibility studies must utilize an approach that will effectively address a key information or data gap in the Recovery Plan or the 6-year Habitat Work Schedule or lead to the implementation of priority projects within 2 years.

3. Coordination and sequencing

Rating	Score Range (0 to 35)
High	24 to 35
Medium	12 to 23
Low	0 to 11

Habitat projects should be designed, coordinated, and sequenced in concert with other salmon recovery activities or needs within a watershed or basin. This can help achieve the greatest benefit to fish in the shortest possible time and with the most efficient use of resources.

Consideration will be given to whether a project is:

a. An element of an existing comprehensive watershed or basin restoration and protection strategy;

b. Well coordinated and logically sequenced with other habitat projects completed, underway, or planned for a watershed or basin; and/or
c. Complementary and supportive of other local and state salmon recovery regulations and programs, including land use and development regulations, critical area ordinances, storm water management programs, shoreline master plans, forest management regulations, etc. d. A logical second phase of a project that had previously received SRFB funding. For example, an implementation project following from a previously-funded design project, or a restoration project following a previously-funded acquisition project.

4. Uncertainties and Constraints

Rating	Score Range (0 to 20)
High	14 to 20
Medium	7 to 13
Low	0 to 6

Each project is reviewed to identify funding, scientific/technical, legal, and/or physical constraints or uncertainties that could significantly impact successful completion of the project. The fewer constraints and uncertainties the higher the project will be scored.

5. Sponsor Qualifications (experience and capabilities)

Rating	Score Range (0 to 20)
High	14 to 20
Medium	7 to 13
Low	0 to 6

The success of a habitat project is dependent on the project sponsor's ability to design, plan, implement and monitor a project. Ideally, project sponsors should have experience in successfully completing projects of similar nature, scope, and complexity. At a minimum, sponsors should indicate how they would acquire needed experience and expertise that they do not possess. Options for doing so could include partnerships with other agencies or organizations, or contracting for needed services.

6. Community and Landowner Support

Rating	Score Range (0 to 25)
High	18 to 25
Medium	9 to 17
Low	0 to 8

The long-term success of habitat restoration and protection efforts depends on the acceptance and support of local communities. Projects should be designed and implemented in a manner that accommodates local values and concerns. LCFRB places a higher priority on projects that will provide long-term benefits for fish by also promoting community support and involvement in salmon recovery.

Having a willing landowner or owners is essential to the success of any on-the-ground project. No project can be implemented or maintained without the consent and support of the landowner. Given the critical importance of landowner support, LCFRB requires a written commitment from the landowner with all project proposals.

7. Stewardship (i.e. maintenance, operation and monitoring)

Rating	Score Range (0 to 10)
High	8 to 10
Medium	4 to 7
Low	0 to 3

The sponsor should identify how monitoring efforts would support maintenance of the project and who would perform maintenance and over what period of time. Maintenance of a completed project may be critical to the project's performance and long-term effectiveness.

c. Final Certainty Rating and Score

A project's overall certainty score is the sum of all certainty scoring factors described above. Based on its overall certainty score, each project is assigned a certainty rating of high, medium, or low certainty of success using the following scale, except if a project receives a "low" rating for any of the individual scoring factors in which case the TAC may assign the project an overall certainty rating of "low" if it concludes that the low factor rating indicates a substantial risk to the overall success of the project.

Table 8. Certainty Rating Table

Project Certainty Score	Project Certainty Rating
140 to 200 pts	High
71 to 139 pts	Medium
0 to 70 pts	Low

2/10/09 LCFRB Evaluation Criteria 11 of 11

Appendix 8.2. Lower Columbia Fish Recovery Board 2009 Habitat Project Application Evaluation Questions.

I.B. BENEFITS TO FISH

I.B.	**BENEFITS TO FISH**		
1.	**Cost: 0-15 pts.** Is the cost of the project reasonable in relation t the expected benefits?	**Rating** High Medium Low	**Score Range** 11 to 15 6 to 10 0 to 5

II. CERTAINTY OF SUCCESS

II.	CERTAINTY OF SUCCESS		
1.	**Scope: 0-15 pts.** ▫ Are the scope & scale appropriate to achieve the stated goals and objectives? ▫ Does the proposal have a well-defined scope that is consistent with and appropriate for the stated goals and objectives?	**Rating** High Medium Low	**Score Range** 11 to 15 6 to 10 0 to 5
2. a.	**Approach: 0-75 pts.** <u>Acquisition/Restoration Projects:</u> ▫ Does the proposal apply appropriate and proven methods and technologies? ▫ Does the proposed approach adequately provide for and incorporate watershed and site conditions that could affect its success? ▫ To what extent does the proposal address the causes of degraded habitat conditions rather than symptoms? ▫ To what extent does the proposal address how watershed conditions and processes will affect the long-term success of the proposed project? ▫ To what extent does the proposal identify and address potential positive and/or negative impacts on upstream, downstream, and/or adjacent habitat conditions? ▫ If acquisition, is this approach necessary to achieve the project's objective? ▫ What is the threat to the site? How imminent is the threat?	**Rating**	**Score Range**
	OR	High Medium Low	51-75 26-50 0-25
b.	<u>Assessments, designs and feasibility studies:</u> ▫ Will the proposed methodology effectively address an information gap identified in the recovery plan or habitat work schedule or lead to implementation of priority projects within two years? ▫ Will the project provide "critical" information needed to make effective and sound habitat or watershed restoration decisions? ▫ Will the proposed approach adequately address watershed and site conditions? ▫ Will the proposed project address causes of degraded watershed processes and/or habitat conditions rather than symptoms?		

II.	CERTAINTY OF SUCCESS Continued		
3. a.	**Coordination/Sequence: 0 to 35 points** Restoration/Acquisition Projects: ▫ Is the proposal designed and located in coordination with other salmon recovery activities in the reach or watershed? ▫ Is it logically sequenced with other restoration needs or projects in the reach or watershed? ▫ To what extent does the proposal address degraded watershed processes and/or habitat conditions in a manner supportive of and compatible with other restoration efforts in the watershed? ▫ Is the project a logical next phase after a previously-funded SRFB project (implementation following a design project; restoration following acquisition, etc)?	**Rating**	**Score Range**
	OR	High Medium Low	24 to 35 12 to 23 0 to 11
b.	Assessments, designs and feasibility studies: ▫ Are the scope, scale, approach, and methods compatible with similar assessments within the watershed and/or region?		
4.	**Constraints/Uncertainties: 0 to 20 points** ▫ What is the potential for funding, scientific/technical, permitting, legal, and/or physical constraints or uncertainties to affect successful implementation of the project? Considerations: permitting, site conditions, access or anthropogenic factors.	**Rating** High Medium Low	**Score Range** 14 to 20 7 to 13 0 to 16
5.	**Qualifications and Experience: 0 to 20 points** ▫ How qualified and experienced is the project team (sponsor and partners) in successfully undertaking projects of similar scope, nature, and magnitude? ▫ Considerations: Demonstrated project management abilities, successful follow through with completing projects on time and within budget.	**Rating** High Medium Low	**Score Range** 14 to 20 7 to 13 0 to 6
6.	**Community Support: 0 to 25 points** ▫ What is the extent of community support for and involvement in the proposal? ▫ Considerations: Has the sponsor obtained significant inkind or cash match? Will local volunteers participate? Will it enhance public knowledge and support? Will it build capacity and interest for future project work? Does the project address local concerns and interests? Is the landowner willing to allow the proposed work to be done?	**Rating** High Medium Low	**Score Range** 18 to 25 9 to 17 0 to 8
7.	**Stewardship and Maintenance: 0 to 10 points** ▫ To what extent does the proposal describe stewardship or maintenance efforts for ten years or more?	**Rating** High Medium Low	**Score Range** 8 to 10 4 to 7 0 to 3

Appendix 9. RPA 35 Tributary Habitat Implementation 2010-2018 – Achieving Habitat Quality and Survival Improvement Targets (NOAA Fisheries 2008 FCRPS BiOp).

The Action Agencies will identify additional habitat projects for implementation based on the population specific overall habitat quality improvement still remaining in Table 5 below. Projects will identify location, treatment of limiting factor, targeted population or populations, appropriate reporting metrics, and estimated biological benefits based on achieving those metrics. Pertinent new information on climate change and potential effects of that information on limiting factors will be considered.

a) During 2010 to 2018, the Action Agencies will provide funding and/or technical assistance to implement specific habitat projects to achieve the specified habitat quality improvements listed in Table 5. Habitat quality improvements associated with projects will be estimated in advance of project selection by expert panels. The Action Agencies will convene expert panels to estimate changes in habitat limiting factors from the implementation of Action Agency habitat actions.

- The Action Agencies shall convene an expert panel to evaluate the percent change in overall habitat quality at the population scale from projects implemented previously (if quantitative objectives not met) and projects proposed for the implementation until the next check-in.
- The expert panel will use methods consistent with the *NWR v. NMFS* Remand Collaboration Habitat Workgroup process.
- Project proposals will clearly describe the completed project in terms of quantitative habitat metrics which can be used to quantitatively evaluate progress and completion of individual projects.
- The Action Agencies will use the expert panels to provide input on changes in habitat quality and function as a result of limiting factor improvements from project actions for the priority population areas and this information will be used to assess improvements to salmonid survival.

If actions from the previous cycle prove infeasible, in whole or in part, the Action Agencies will ensure implementation of comparable replacement projects in the next implementation plan cycle to maintain estimated habitat quality improvements at the population level and achieve equivalent survival benefits. If infeasible at the population level, then alternatively replacement projects will be found to provide benefits at the MPG or ESU/DPS level. Selection of replacement projects to ensure comparable survival benefits will be made based on input from expert panels, regional recovery planning groups, the Northwest Power and Conservation Council, and NOAA Fisheries. The Action Agencies will continue to work cooperatively with the Council to identify priorities and obtain ISRP review of projects proposed for BPA funding.

- RM&E will inform the relationship between actions, habitat quality and salmon productivity for use in a model developed through the FCRPS RM&E Strategy 3, Action

57 and new scientific information will be applied to estimate benefits for future implementation.

- If new scientific or other information (except incomplete implementation or project modifications) suggests that habitat quality improvement estimates for projects from the previous cycle were significantly in error, the Action Agencies will examine the information and review the project or projects in question and their estimated benefits. This review will occur as part of the 2009 Annual Report and the Comprehensive RPA Evaluations in 2013 and 2016 and will be performed in conjunction with NOAA Fisheries.

In the event such review finds that habitat quality improvement benefits were significantly overstated, the Action Agencies will implement replacement projects (selected as per Action 35 above) to provide benefits sufficient to achieve the habitat quality improvement and population- or MPG-specific survival benefit estimated for the original project or projects.

b) During 2010-2018, for non-bolded populations in Table 5, the Action Agencies may provide funding and/or technical assistance for replacement projects should they become necessary for the Action Agencies to achieve equivalent MPG or ESU survival benefits.

c) For those lower Columbia populations above Bonneville Dam that have been significantly impacted by the FCRPS (CR chum, LCR coho, LCR Chinook, and LCR steelhead) the Action Agencies may provide funding and/or technical assistance for habitat improvement projects consistent with basin wide criteria for prioritizing projects, including Recovery Plan priorities.

Appendix 10. List of Key Project Personnel and Résumés

Bryce Glaser – WDFW Fish Biologist 4 – Region 5 Anadromous Fish/ESA Unit Lead
Todd Hillson – WDFW Fish Biologist 3 – Region 5 chum biologist
Steve Schroder – WDFW Research Scientist - Ecological Investigations Unit Lead
Daniel Rawding – WDFW Natural Resource Scientist – Stock Assessment Unit
Steve Vigg – WDFW Columbia River Projects Coordinator

Bryce Glaser

EDUCATION:

B.S. in General Biology from University of Hawaii at Manoa (1992)

RECENT PREVIOUS EMPLOYMENT:

2006 – Present Fish Biologist 4, WDFW, Southwest Region (5), Vancouver , WA.
2002 – 2006 Fish Biologist 3, WDFW, Southwest Region (5), Vancouver , WA.
1999 – 2002 Fish Biologist 2, WDFW, Southwest Region (5), Vancouver , WA.
1995 – 1999 Oceanographic Research Assistant, U. of Hawaii at Manoa, HI.
1993 – 1995 Scientific/Fisheries Technician, WDW & WDF, Southwest, WA.

CURRENT RESPONSIBILITIES -Lead biologist for the Region 5 Anadromous Fish/ ESA Unit, including wild salmon and steelhead monitoring and recovery planning/ implementation efforts in the Lower Columbia River. .

EXPERTISE -Seven years experience directly related to monitoring and managing steelhead and salmon populations including, utilizing mark-recapture, Area-Under-the-Curve, redd count expansion, and EMAP methodologies for adult and juvenile abundance monitoring; supervising field crews and participating in field work to accomplish the above. Work specific to the Grays River includes – adult wild winter steelhead, fall Chinook, and chum population monitoring, and juvenile salmonid outmigrant monitoring.

SELECTED PUBLICATIONS:

Rawding, D. and B. Glaser. In prep. Draft progress report: Escapement of tule fall Chinook salmon in the Coweeman River. Draft Progress report to WDFW. August 2006. 10 pp.

Rawding, D., B. Glaser, and S. VanderPloeg. 2006. 2005 adult winter steelhead abundance and distribution in Germany, Abernathy, and Mill Creeks. Wash. Dept. of Fish and Wild. Vancouver, WA. 14 pp.

Rawding, D., T. Hillson, B. Glaser, K. Jenkins, and S. VanderPloeg. 2006. Abundance and Spawning Distribution of Chinook Salmon in Mill, Abernathy, and Germany Creeks during 2005. Wash. Dept. of Fish and Wild. Vancouver, WA. 37pp.

Sharpe, C. S., and B. Glaser. 2005 Coweeman River Juvenile Salmonid Production Evaluation. Completion report to WDFW 30pp.

Todd Hillson

EDUCATION

B.S. Wildlife Science, Oregon State University, 1988

RECENT PREVIOUS EMPLOYMENT

2001 – present Washington Department of Fish and Wildlife, Fisheries Biologist 3
1996 – 2000 Washington Department of Fish and Wildlife, Fisheries Biologist 2

CURRENT RESPONSIBILITIES – Region 5 chum salmon biologist, Anadromous Fish/ ESA Unit. Project lead for WDFW's portion of the Historic Habitat Opportunities and Food-Web Linkages of Juvenile Salmon in the Columbia River Estuary and Their Implications for Managing River Flows and Restoring Estuarine Habitat (BPA Project # 200301000). Project lead for the Reintroduction of Chum salmon into Duncan Creek (BPA Project # 200105300). Project lead for WDFW's adult salmonid weir operations on the Grays River.

EXPERTISE – 18 years of fisheries research involving salmonids and two years of salmonid aquaculture. Work experience includes seven years conducting smolt monitoring at mainstem Columbia and Snake River hydropower facilities. Four years as the Lewis River Hatchery evaluation biologist conducting research relating hatchery operations/conditions to return rates of adult salmonids. Seven years of conducting mark/recapture experiments (Jolly-Seber model) to estimate adult salmonid populations. Nine years of experience conducting smolt trapping in both large and small streams using rotary screw traps and fence-panel weirs.

SELECTED PUBLICATIONS

Hillson, T. D. and Rawding, D. 2004. Reintroduction of Lower Columbia River Chum Salmon into Duncan Creek (BPA Project No. 200105300) Council Three-step Review.

Hillson, T. D. In Prep. Re-Introduction of Lower Columbia River Chum Salmon into Duncan Creek Annual Report for 2008, Report to Bonneville Power Administration, Contract No. 00007373, Project No. 200105300.

Rawding, D. and T. D. Hillson. 2002. Population estimates for chum salmon spawning in the Mainstem Columbia River, 2002. Project 2001-05300, 47 electronic pages, (BPA Report DOE/BP-00007373-3).

Rawding, D. and T. D. Hillson. 2008. Population estimates for chum salmon spawning in the Mainstem Columbia River, 2008. Project 2001-05300. In Prep

Steven L. Schroder

EDUCATION

Ph.D. Fisheries Science. University of Washington
M.S. Fisheries Science. University of Washington
B.S. Fisheries Science. University of Washington

RECENT PREVIOUS EMPLOYMENT
1990-Present Fisheries Research Scientist II, Washington Department of Fisheries and Wildlife.

CURRENT RESPONSIBILITIES – Leader of the Ecological Investigations Unit in the Science Division, Fish Program, Washington Department of Fish & Wildlife. The Ecological Investigations Unit possesses five subgroups. One of these is WDFW's Otolith Laboratory which is responsible for thermally marking up to 50 million embryonic salmonids per year, examining otoliths for thermal marks, using micro-chemistry signals in otoliths to decipher natural life history events, and inducing and decoding strontium marks in salmonids and marine fishes. A Fish Aging subgroup produces all the age estimates for salmonids, marine, and freshwater fishes for WDFW. A third group investigates how to carry out selective fisheries on salmonids by evaluating the effects of various types of capture gear on the survival and reproductive success of salmonids. The fourth group, referred to as the Large Lakes Research Team, examines limiting factors and productivity of fishes in lakes throughout the state, while the fifth group is involved with the recovery of depressed or listed salmon stocks, investigates the effects of hatchery culture (e.g. domestication) and also evaluates the reproductive success of wild and hatchery origin salmonids.

EXPERTISE – Over 35 years of fisheries research that has ranged from evaluating the effects of biological and environmental factors on the survival and productivity of salmonid populations to inventing, testing, and using new marking methods (thermal marking and strontium marking) on salmonids and other fishes. Specific areas of interest are: reproductive ecology of salmonid fishes, gamete quality assessments of hatchery and wild salmonids, evaluating alternative salmonid fish cultural methods (incubation methods, feeding regimes, release strategies, modifications to rearing areas), developing and testing fish marking tools, examining juvenile salmon ecology in freshwater and estuarine areas, and recovery of depressed or ESA listed salmonids via habitat alterations and fish cultural methods. Has co-authored over 40 peer-reviewed journal articles, book chapters, and technical reports.

SELECTED PUBLICATIONS

Berejikian, B.A., E.P. Tezak, L. Park, E. LaHood, S.L. Schroder, and E. Beall. 2001. Male competition and breeding success in captively reared and wild coho salmon (*Oncorhnchus kisutch*). Can. J. Fish. Aquat. Sci. 58: 804-810.

Gaudemar, B., S.L. Schroder, and E.P. Beall. 2000. Nest placement and egg deposition in

Atlantic salmon redds. Environmental Biology of Fishes 57: 37-47.

Knudsen, C.M., S.L. Schroder, C.A. Busack, M.V. Johnston, T.N. Pearsons, W.J. Bosch, and D.E. Fast. 2006. Comparison of life history traits between first generation hatchery and wild upper Yakima River spring Chinook salmon. Transactions of the American Fisheries Society. 135:1130-1144.

Knudsen, C.M., S.L. Schroder, C.A. Busack, M.V. Johnston, T.N. Pearsons, and C.R. Strom. 2008. Comparison of female reproductive traits and progeny of first-generation hatchery and wild upper Yakima River spring Chinook salmon. Transactions of the American Fisheries Society 137:1433-1445.

Schroder, S.L., C.M. Knudsen, T.N. Pearsons, T.W. Kassler, S.W. Young, C.A. Busack, and D.E. Fast. 2008. Breeding success of wild and first-generation hatchery female spring Chinook salmon spawning in an artificial stream. Transactions of the American Fisheries Society 137:1475-1489.

Schroder, S.L., C.M. Knudsen, E.C. Volk. 1995. Marking salmon fry with strontium chloride solutions. Can. J. Fish. Aquat. Sci. 52:1141-1149.

Schroder, S.L., E.C. Volk, C.M. Knudsen, and J.J. Grimm. 1996. Marking embryonic and newly emerged salmonids by thermal events and rapid immersion in alkaline-earth salts. Bull. Natl. Res. Inst. Aquacult., Supple. 2:79-83.

Volk, E.C., S.L. Schroder, and J.J. Grimm. 2005. Otolith thermal marking. Pages 447-463 *In* S.X. Cardin, K.D. Friedland, and J.R. Waldman (ed.s) Stock Identification Methods, Elsevier Press.

Daniel J. Rawding

Experience

1995-Present Natural Resource Scientist, Washington Department of Fish and Wildlife, White Salmon, WA.

Current Responsibilities:. Lead agency scientist for salmon and steelhead population monitoring and salmon recovery in the Lower Columbia River. Responsible for evaluation and development of population monitoring programs for salmon and steelhead, fisheries and hatchery risk assessments, application of EDT for salmon recovery, and representing WDFW on NOAA-Fisheries and USFWS technical recovery teams for salmon, steelhead, and bull trout.

1982-86,89-94 District Fish Biologist, Washington Department of Fish and Wildlife, Region 5, Vancouver, WA.
1986-1988 Fish Biologist, U.S. Army Corps of Engineers, Cascade Locks, OR.
1982-1984 Fishing Guide, Royal Coachman Lodge, Dillingham AK.
1984,81 Fisheries Technician, Washington Department of Natural Resources, Fish Program, Forks,WA, and U.S. Forest Service, Tongass National Forest, Sitka, AK.

Education:	**School**	**Degree and Date Received**
	University of Washington, Seattle	B.S. Fishery Science, 1982

Selected Publications:

Rawding, D., and M. Groesbeck. 2005. 2004 Cedar Creek juvenile salmonid production evaluation. Washington Department of Fish and Wildlife, Region 5 Fish Program. Vancouver, WA. 24pp.

Rawding. D. and P.C. Cochran. 2005. Wind River Winter and Summer Steelhead Adult and Smolt Population Estimates from Trapping Data, 2000 – 2004. Report to Bonneville Power Administration, Contract # 199801900, 33 electronic pages.

Rawding, D., and T. Hillson. 2005. Population Estimates for Chum Salmon Spawning in the mainstem Columbia River, 2004.

Hillson T. D. and Rawding D. 2004. Washougal Hatchery Chum Salmon Combined Three-step Review. Washington Department of Fish and Wildlife, Vancouver WA.

McElhaney, P., T. Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J. Meyers, D, Rawding, D. Shively, A. Steel, C. Steward, and T. Whitesel. 2003. Interim report on viability criteria for Willamette and Lower Columbia Basin Pacific Salmonids. NOAA-Fisheries. Northwest Fisheries Science Center. Seattle, WA.

Steven C. Vigg

<u>EDUCATION:</u>

1968-70	**A.A.** in Biology, Palomar Jr. College, San Marcos, CA
1971-73	**B.S.** in Fisheries, Humboldt State Univ., Arcata, CA (GPA= 3.42)
1974-75	**M.S.** in Natural Resources, Humboldt State Univ., Arcata, CA (GPA= 3.88)
1979-84	Post-Graduate level Biology courses; University of Nevada, Reno, NV (82 Semester Units - GPA= 3.57)
1986	Ph.D. program coursework in fisheries and quantitative science; University of Washington, Seattle, WA (52 Quarter Units - GPA= 3.71)

EXPERTISE

- ❖ Columbia River Basin Anadromous and Resident Fish Enhancement
- ❖ FCRPS – Restoration Strategies – to Protect, Mitigate and Enhance Fish & Wildlife and their habitats
- ❖ Effects of Fish Predation on Out-Migrating Juvenile salmonids
- ❖ State, Federal, and Tribal Fisheries Management in the Columbia Basin
- ❖ Columbia Basin Conservation Enforcement as a Fish Restoration Strategy; Monitoring & Evaluation of the Efficacy of Conservation Enforcement
- ❖ Development of Anadromous and Resident Fish Management Plans
- ❖ Endangered Species Act – Fish Recovery Strategies and Compliance
- ❖ FERC – Fish Re-introduction Strategies and Compliance
- ❖ Limnology and Ecology of the fishes of the Great Basin
- ❖ Business Acumen – Personnel and Project Management & Budget

CURRENT RESPONSIBILITIES:

<u>02/2006 to Present:</u>

Washington Department of Fish & Wildlife; Region 5 Fish Management Harvest Manager, WMS-2; Fish Program – Region Five, Vancouver, Washington:

This position has full responsibility to manage and implement the Fish Management staff and activities in Region 5 (Southwest Washington and Lower Columbia River). These activities include managing the fish resources in the lakes and streams within the region to ensure healthy and diverse populations while maximizing sport and commercial fishing opportunities. This position manages a staff of 36 full time and 102 career seasonal and temporary employees with an annual operating budget of $4 million. Key responsibilities for this position are: stock status assessment, harvest management, Salmon Recovery, and coordinating with state and federal agencies, tribal, and volunteer groups. Duties include:

- Manage and direct the fisheries assessment and management activities within Region 5.
- Ensure staff compliance and consistent recover efforts associated with federal and state programs.

- Lead cross program coordination between other Divisions and Programs within the Region.
- Manage Regional Fish Management Budget.

PREVIOUS EXPERIENCE:

10/1998 to 02-2006:

I owned and operated an independent Natural Resources Consulting Company – Steven Vigg & Company (Subchapter S Corporation)

Consultant on Columbia River Basin fishery issues, with an emphasis on enhancement of ESA-listed anadromous salmonid stocks.

6/1995 to 10/1998:

Senior Consultant for S.P. Cramer & Associates, Inc.

I consulted on Columbia River Basin fishery issues, including -- resident & anadromous fish biology, ESA status reviews, harvest, and fish & wildlife law enforcement.

12/1990 to 6/1995:

Fishery Biologist (Management) for Bonneville Power Administration.

I managed and performed analyses and developed recommendations pertaining to the status and improvement of Columbia River Basin fish stocks relative to the Endangered Species Act (ESA).

07/1988 to 12/1990

Supervisory Fish & Wildlife Biologist for Oregon Department of Fish & Wildlife.

I was project Leader for two BPA-funded projects -- the Predator-Prey and Predator Control projects develop ways to reduce predation by northern squawfish on juvenile salmonids in Columbia River reservoirs. I was responsible for initiating a plan for system-wide predator control fisheries in the Columbia River.

07/1984 to 07/1988:

Fishery Biologist U.S. Fish and Wildlife Service; Seattle National Fishery Research Center, Columbia River Field Station, Cook, WA

Investigation of the impact of fish predation on juvenile salmonid populations during downstream smolt migration. I was responsible for estimating the consumption rates of four fish predators on juvenile salmonids – field sampling, lab experiments, modeling, and publications.

SELECTED PUBLICATIONS

Steve Vigg has authored over 100 research, management, and planning documents and has delivered numerous presentations at scientific symposiums. Steve received the American Fisheries Society citation for most significant paper of the year, TAFS 1991. The following selected publications are listed by category.

ECOLOGY AND LIMNOLOGY:

Vigg, S., and D.L. Koch. 1980. Upper lethal temperature range of Lahontan cutthroat trout in waters of different ionic concentration. Trans. Am. Fish. Soc. 109:336-339.

Estep, M.L.F., and S. Vigg. 1985. Stable carbon and nitrogen isotope tracers of trophic dynamics in natural populations and fisheries of the Lahontan Lake System, Nevada. Can. J. Fish. Aquat. Sci. 42:1712-1719.

FISH HARVEST:

Vigg, S. 1992. Changes in harvest management of Columbia River Basin salmon with respect to the Endangered Species Act. Pacific Fishery Biologists, 54th Annual Meeting. March 23-25, 1991. Blaine, Washington.

Cramer, S.P. and S. Vigg. 1996. Quantification of the probable effects of alternative in-river harvest regulations on recovery of Snake River fall chinook salmon. Prepared for Bonneville Power Administration, Portland, Oregon. DOE/BP-99654-14.

FISH PREDATION:

Vigg, S., and C.C. Burley. 1991. Temperature dependent maximum daily consumption of juvenile salmonids by northern squawfish (Ptychocheilus oregonensis) from the Columbia River. Can. J. Fish. Aquat. Sci. 48:2491-2498.

Vigg, S., T.P. Poe, L.A. Prendergast, and H.C. Hansel. 1991. Rates of consumption of juvenile salmonids and alternate preyfish by northern squawfish, walleyes, smallmouth bass, and channel catfish in John Day Reservoir, Columbia River. Trans. Am. Fish. Soc. 120:421-438.

CONSERVATION LAW ENFORCEMENT:

Vigg, S. (editor). 1995. Increased levels of harvest & habitat law enforcement and public awareness for anadromous salmonids and resident fish in the Columbia River Basin -- Project 92-024 Final Report for the demonstration period, 1992-94. June 31, 1995. Bonneville Power Administration, Portland, Oregon. 75 pp.

Vigg, S.C. 2005. Development of a strategic plan to facilitate cooperative enforcement efforts between NOAA Fisheries Office for Law Enforcement and Columbia Basin Tribes. Performance Report for 2005 to the NOAA Fisheries, Northwest Region Office for Law Enforcement. Purchase Order AB133F04SE1550. December 31, 2005. Steven Vigg & Company, Corbett, Oregon. 59 Pages.

NATURAL RESOURCES MANAGEMENT PLANS:

Resident Fish Manager’s Caucus of the Columbia Basin Fish & Wildlife Authority (RFM-CBFWA). 1997. Draft Multi-Year Implementation Plan for Resident Fish Protection, Enhancement & Mitigation in the Columbia River Basin. (Steven Vigg, editor). April 24, 1997 Draft. Columbia Basin Fish & Wildlife Authority, Portland, Oregon.

Shoshone-Paiute Tribes and Owyhee Watershed Council. 2004. Owyhee Subbasin Plan. Steven C. Vigg, Editor. Final Draft. Submitted to the Northwest Power and Conservation Council, Portland, Oregon. May 28, 2004.

HYDROPOWER:

Vigg, S. 1994. Session Chairman -- Engineering and Fish Passage. Pacific Fishery Biologists 56th Annual Meeting, Konocti Harbor Inn, Clear Lake, California. April 11-13, 1994.

Vigg, S. 1997. Biological consultation on the potential effects & mitigation of the Yang Yang Pumped Storage HydroPower Project -- on chum salmon in the Nam Dae Chun River, Korea. Prepared for Saman Engineering Consultants Co., LTD., and the Korea Electric Power Corporation. March 10, 1997

HATCHERIES:

Vigg, S. 1999. Biological Assessment for the operation of hatcheries funded by the National Marine Fisheries Service under the Columbia River Fisheries Development Program – with an emphasis on the steelhead (Oncorhynchus mykiss) Evolutionarily Significant Units (ESU's) listed under the Endangered Species Act: the Lower Columbia River ESU, Threatened; the Snake River Basin ESU, Threatened; the Upper Columbia River ESU, Endangered. Final Draft March 15, 1999. Submitted to: the National Marine Fisheries Service, Sustainable Fisheries Division, Harvest and Hatcheries Branch, Portland, Oregon.

Vigg, S. , B. Glaser, and W. Dammers. 2008. Regional Evaluations of Mitchell Act Operations, Southwest Washington, April 1, 2007 – September 30, 2007 – With a Summary of Data for the Previous 5-Years, 2002-2006. Semi-Annual Report #1 on the FY2007 WDFW Region 5 Lower Columbia River Fisheries Development Program, Regional Mitchell Act Hatchery Evaluations – to NOAA Fisheries. May 20, 2008. Prepared by Washington Department of Fish & Wildlife, Region 5, Fish Management, Vancouver, Washington. 165 pages.